THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

PUBLISHED MONTHLY AT No. 145 BROADWAY, NEW YORK.

M. N. FORNEY, ... Editor and Proprietor.
FREDERICK HOBART. . . . . Associate Editor.

Entered at the Post Office at New York City as Second-Class Mail Matter.

SUBSCRIPTION RATES.

Subscription, per annum, Postage prepaid $3 00
Subscription, per annum, Foreign Countries 3 50
Single copies 25

Remittances should be made by Express Money-Order, Draft, P. O. Money-Order or Registered Letter.

NEW YORK, JULY, 1889.

THE Chesapeake & Ohio Canal was very badly damaged in the recent freshets, and there seems to be some doubt as to whether it will be possible to secure the necessary capital to repair or rebuild it. The canal runs from Georgetown to Cumberland, and the State of Maryland is the principal stockholder. Its chief traffic is in coal from the Cumberland region, and while it carries very much less of that coal than the railroads do, it has been of considerable importance as a regulator of rates.

THE Governor of the State of New York has approved the bill providing for the organization of a Naval Reserve, which is to consist of three battalions, to be divided between the seaboard and the lakes. They are to be part of the National Guard of the State, and to be governed by the same laws. The Naval Battalions will be composed of persons engaged in seafaring pursuits, and will be drilled in accordance with naval rules. They are to have also a period of sea training each year, provided the United States will furnish the proper vessels. The law is very similar to that proposed to Massachusetts and one or two other States.

THE Cincinnati Association of the Society of Civil Engineers has prepared for submission amendments to the Constitution of the American Society, bringing up again what has been proposed several times before this, the division of the Society into districts, arranged geographically, and an adjustment of the representation in the Board of Directors by districts. The reasons for this are stated in a pamphlet which has been issued by the Society and generally distributed.

THE connections of the Poughkeepsie Bridge are finally completed, as far as laying track is concerned, and trains will begin to run over the bridge early in July. The Western connection is an extension of the Lehigh & Hudson River Railroad, and through that road connects with the Erie, the Lehigh Valley, and the Pennsylvania Railroads. The Eastern line extends from Poughkeepsie to a connection with the Hartford & Connecticut Western road, which will be the main outlet eastward for traffic passing over the bridge, at least until a further connection is made with the New York & New England.

SUBMARINE torpedo-boats are now engaging a good deal of attention among naval men, both in this country and in Europe. Some French experiments have been made with a boat, which is described as being spindle-shape, 6 ft. in diameter by 56 ft. in length ; provided with torpedo-tubes and driven by electricity, the power being furnished by storage batteries, while the submersion of the boat is regulated by means of water tanks. There is some mystery surrounding the result of these experiments, but it is reported that the boat has been very successful. French officers are also experimenting with a smaller boat of a similar shape, but 15 ft. long only and carrying but two men. The service this small boat is to do is as a detector of submarine torpedoes and mines, and a destroyer of the wires and cables which serve as their sure connections.

An appropriation has been made for the construction of a submarine boat for our own Navy, and the Navy Department has now under consideration bids received for the same. The one which will most probably be accepted is from the Columbian Iron Works, of Baltimore, for a vessel having 12 knots surface speed and 9 knots submerged speed, the general design of which is similar to what is known as the Holland boat ; the motive power of this vessel will be steam generated by burning petroleum, while the boat is running on the surface and stored up in the boilers when she is submerged. She is to be submerged automatically by means of rudders on either side, which are to be so arranged as to plunge her beneath the water. Even when running on the surface, she will be invisible at a comparatively short distance, and should be able to use her dynamite gun very effectively at close range.

THE Atchison, Topeka & Santa Fé is a striking example of the condition into which over-building, over-confidence, the rage for acquiring new "territory," and the resulting excessive competition have brought the railroads of the Southwest. Only a short time ago the Atchison was one of the soundest of the new railroad properties, with a well-placed system of roads, commanding a large traffic and not only earning its fixed charges, but paying 6 per cent. dividends—actually earned—on its stock. The entrance of other lines into its field was to be expected, and the effort to meet them by covering the territory with branches was perhaps not unnatural ; but it has resulted, as all such contests do result, in disaster, the company which expanded most recklessly being the first to fail.

Building branches and extensions in advance of settlements to develop new country is justifiable in many cases, and the result may be good if a railroad can keep the business to itself ; but building competing lines to fight for business which does not yet exist is a dangerous experiment, as the railroads found out in the Northwest some time ago. In the Southwest it has been tried over again with results which threaten to be more disastrous, because the process has been carried further, and in a country in which growth is slower and is also of a variable and intermittent kind, and which has fewer natural resources. In Wisconsin, Iowa, Minnesota, Nebraska, and Dakota there has been sharp competition among the railroads, with consequent reduction of rates to a point at which the margin of profit

is very small; but this has been partly made up by a steady increase in business, since in that region settlement is of a more stable character, the crops are more regular, and the bulk of traffic to be carried much greater than is ever likely to be the case in a dry region like Western Kansas, or a grazing and pastoral country like New Mexico and Southern Colorado and Texas; while a mining region like Central Colorado or Arizona is notoriously unreliable as a source of traffic.

Careful financial management may pull the Atchison through with some difficulty, and enable it to carry its heavy load until better times come; but its present condition is a severe lesson which will be learned by its rivals and other observers, and will be heeded—until the next "boom" comes.

THE JOHNSTOWN DISASTER.

THE story of the catastrophe in the Conemaugh Valley has been so fully told in the daily papers that it would be a waste of time to attempt to describe it in detail here. It is but a repetition on a larger scale of more than one previous accident of the kind, the disastrous results in this case being due to the fact that a large population had been concentrated around the flourishing iron and steel works situated in the narrow valley.

To give the story as briefly as possible, a dam on the South Fork of the Conemaugh, above which was a lake, or reservoir, containing some 480,000,000 cubic feet of water, gave way under the pressure of a flood caused by an unusually heavy rain. This vast mass of water swept through the narrow valley, confined by the high hills on either side, wrecking almost completely the villages and towns in its path. These included South Fork, Mineral Point, Conemaugh, Woodvale, Johnstown, and Cambria City, the two last-named including the great Cambria Iron Works, the Gautier Steel Works, and other manufactories, with a large working population attached to them. These factories and the dwellings of some 38,000 people may be said to have disappeared; and so sudden was the failure of the dam and so rapid the rush of water that hardly any warning was given, and the people generally had not time to escape, although the hills were within a short distance. The loss of life is variously estimated, but appears to have been not far from 7,000 persons; probably the numbers will never be accurately ascertained. The loss of property was enormous, and fell largely on those who were very little prepared to bear it.

Some idea of the force of the water may be gathered from the fact that 30 locomotives in the round-house of the Pennsylvania Railroad—most of them heavy mountain engines used on the steep grades between Johnstown and Altoona—were carried away for considerable distances, and up to date three of them have not been found, being probably completely buried somewhere under the mass of wreck and rubbish brought down by the flood.

The immediate cause of the accident was, of course, the extraordinary rainfall, which resulted in much damage at other points also, but the secondary and perhaps most important cause was the existence of a reservoir and the condition of its dam above the scene of the disaster.

This dam was originally constructed to form a reservoir from which water was drawn to supply the Western Division of the Pennsylvania Canal; it was about 850 ft. long, 62 ft. high in the center, 50 ft. wide on top and 300 ft. at the bottom, built of earth and stone, and provided with a waste-way or overflow at one end, 75 ft. wide and 4 ft. below the top of the dam, cut through the rock on the hillside. The lake or reservoir flooded some 450 acres, and when full, contained about 480,000,000 cubic feet of water. The dam was completed in 1852; some five years later the canal was sold to the Pennsylvania Railroad Company, and later its use as a waterway was given up. The reservoir was then not required, and when a breach developed in it some years later it was not stopped up, and the stream was allowed to cut it away gradually, making a gap 150 ft. wide and extending down nearly to the bottom, thus reducing the reservoir to very small proportions. About 1880 the adjoining property was bought by an association, chiefly composed of Pittsburgh people, who used it for sporting purposes; they decided to restore the lake to its former proportions by rebuilding the dam.

As to its repair, or reconstruction, the testimony is somewhat conflicting, but the work seems to have been done by adding earth and stone, as in the original dam, until its former dimensions were very nearly restored. Testimony is somewhat conflicting also as to the care taken of its condition, but it is asserted that there had been some settling, so that the center was lower than the ends by several feet. It is also stated that it had been inspected from time to time by engineers of the Pennsylvania Railroad Company, who pronounced it safe.

The failure was due to the fact that the heavy rainstorm raised the level of water in the lake much faster than the waste-way could carry it off, so that water began to run over the crest of the dam, and cut away the earth—of which the dam was formed—on its exposed side. The failure occurred because those who built and those who should have maintained the dam neglected to provide these safeguards, the absolute need of which forms part of the elementary knowledge of the principles which should govern the construction of earthwork dams. Thus, in an article on this subject in the Encyclopædia Britannica, it said that "the length of the weir (of a dam) should be made sufficient for the discharge over it to pass off the inflow during a flood, so as to insure the dam against being overtopped by a rise of water in the reservoir, *which would be fatal to an earthen dam.*" Over and over again the lesson has been taught, that if there is not sufficient provision for the discharge of the water of a flood, that the overflow will "be fatal" to such structures, and yet the lesson must be emphasized by the sacrifice of thousands of lives in order to be impressed on the minds of those who assume the responsibility of building and maintaining structures of this kind. All such persons should ask themselves whether there is sufficient provision for the overflow of the greatest flood of which there is any knowledge, and then provide for a flood twice as great. In cases where an *insufficiency* may be fatal, safety can only be assured by *superabundance*, a lesson, by the way, which human nature is very slow in learning.

At Hanover, York County, Pa., another earthwork dam, for the storage of a water supply, was washed away by the same storm. The dam failed from the same causes to which the disaster at Johnstown was due; that is, the waste-way or weir was not large enough to carry off the water of the flood. A dam on the same site was destroyed in the same way only five years ago. Happily in neither case was there any loss of life, and, excepting the dams, not much to property.

No judicial investigation into the construction of the dam has been made, and it does not yet appear that any official examination has been ordered. The American Society of Civil Engineers has appointed a committee of its members, but they will, of course, have no more authority than any other persons to examine the work, although the names of the members may give weight to any report they may make.

The same remarkable rain-storm which caused the flood in the Conemaugh extended over all of Central Pennsylvania and Maryland, causing floods everywhere in that region with great damage to property, though with little loss of life elsewhere than at Johnstown. The Pennsylvania Railroad Company, whose lines cover all the flooded district, was the heaviest loser. Its main line from Harrisburgh to Pittsburgh has been blocked for nearly three weeks, losing many bridges, both large and small, and having the road-bed itself destroyed for a considerable distance. The Philadelphia & Erie and the Northern Central both suffered in the same way, and the total loss to the railroad has been estimated as high as $8,000,000. The Baltimore & Ohio Railroad also suffered damage, but very much less than the Pennsylvania, as its position was for the most part on the outskirts of the flooded region, and not directly in the center of it, as the other company's lines were.

The storm, indeed, seems to have been a sort of local blizzard, very similar to that which struck New York and the Eastern seaboard somewhat over a year ago, except that it was accompanied by rain instead of snow. Its effects were more disastrous, in fact, than those of the blizzard.

The immediate effect of the Johnstown flood will doubtless be a general overhauling of dams everywhere, and a general feeling of anxiety among people living in the neighborhood of such structures. Whether it will produce any very lasting effect in the way of providing for supervision of any kind or greater care in construction remains to be seen. The Mill River catastrophe in Massachusetts was forgotten in a few months, and the Johnstown accident—more disastrous in its results, because the efforts of the flood were concentrated—may share the same fate, and in a year will hardly be remembered, outside of the circle of immediate sufferers. Engineers may take the warning, but it is very doubtful whether they will find it any easier hereafter to persuade the capitalist or the company which builds dams to spend the money required for safe structures.

The greatest accident of the kind on record, with its thousands of lost lives and its measureless loss and suffering, will, it is to be hoped, have for result that no similar structures will hereafter be built, without the advice and supervision of a competent engineer.

COUNTRY ROADS.

THE Engineers' Society of Western Pennsylvania has taken up the question of the improvement of country roads in earnest, and at the last meeting of that Society a long report was presented by the committee to which the question was referred. The first part is largely taken up with calculations as to the value of good roads to a community, on which point there is nothing specially new to be said, since the subject has been so often gone over before. It will be sufficient to say that the result of their calculations is that a team can haul fully 50 per cent. more on a good macadamized road than on a clay road in fair condition, and that on this basis, at a low estimate, the yearly saving to the people of Pennsylvania would be not less than $2,000,000, an amount sufficient to keep some 30,000 miles of good road in repair. To this it may be added that the great majority of our country roads are usually in poor condition, and that the Committee would hardly go beyond the mark had they assumed the increased load on a properly made and kept road at a much higher percentage.

Under the present wasteful system of maintaining local roads in most of our States, the normal condition of the roads is sure to be bad, and the load hauled is not more than one-half of what a horse should be able to take on a good road. Unfortunately, the loss incurred is so distributed that very few people realize how great it is. If they did there would be a universal demand for improvement, and the small addition to the road taxes which would be required would be welcomed as an actual saving. The difficulty is to make the great majority of the voters in rural townships see and appreciate this fact.

Another part of the report calls attention to a question about which very little has so far been said in the discussion, and that is, with regard to the location of roads. It is too often the case that a road when first located by the highway commissioners, the town committee or other local authorities, is laid out without the slightest reference to engineering principles, and entirely with regard to local considerations, such as farm boundary lines. Any one who has given any attention at all to the subject can recall numerous instances where long detours have been made, hills have been climbed and unnecessary grades put in for just such reasons, and locations been made which no engineer would entertain for an instant. The local authorities in charge usually entirely ignore the fact that the capacity of a vehicle is limited by what engineers call the "ruling gradient," and that a single steep hill will cut down the load which can be hauled over a number of miles of road. They also seem to forget that while horses may be urged at such points to extra effort, and while the results may not be immediately apparent, the injury is still there, so that a badly located road will not only diminish the carrying power of all the vehicles in the neighborhood, but will also, in the end, shorten the lives of many, if not all, of the draft animals owned in the neighborhood, which should be a serious consideration to the farmer. Moreover, the injury done by a badly-located road with unnecessary grades is cumulative; it goes on year after year, increasing as the neighborhood grows, and may continue to inflict injury long after the original locators are dead and forgotten. A farmer will grumble at a toll-gate on a turnpike, and will resort to all sorts of measures either to avoid it or to have it done away with; but he does not seem to realize the fact that an unnecessary grade or an addition to the length of the road made to accommodate a neighbor's boundary line is really a toll-gate more costly than any to be found on a turnpike.

In the West and in the newer States the country roads generally follow the township and section lines, and in a fairly level country this makes but little difference. It is in the older States of the East that the greatest faults in this respect are to be found. That the statements above are not at all exaggerated could be easily proved in a day's drive in almost any district in the New England States, New York, New Jersey, or Pennsylvania.

The conditions and methods of making and repairing roads all need improvement and all deserve study, but the first step in a reform should be the employment of competent engineers to locate the roads. The instances are not few where the saving which could be effected in a single year would be enough to pay for all that the services of an engineer would cost.

The Engineers' Society of Western Pennsylvania deserves credit for taking up the matter, and it is to be hoped that interest in it will not be lost, and that its missionary efforts will be continued. With its report the Committee submitted the draft of a bill to be presented to the Pennsylvania Legislature. This bill provided for the division of roads into three different classes, according to their importance, and regulating the methods to be employed in building, repairing, and supervising each class. The details of this bill we have not had time to examine; but we believe that it embodies the principle upon which all improvement must rest—the formation of larger districts, with county or State supervision, so that the roads may be placed in charge of competent persons, who can devote their time to the business and receive proper compensation. This, with some system of general supervision by States or large districts, and the abolition of the present vicious system of "working out" road taxes, seem to us to be essential, if we are to have a really good system of country roads.

NEW PUBLICATIONS.

A THEORETICAL AND PRACTICAL TREATISE ON THE STRENGTH OF BEAMS AND COLUMNS; *in which the ultimate and the elastic limit strength of beams and columns is computed from the ultimate and elastic limit compressive and tensile strength of the material, by means of formulas deduced from the correct and new theory of the transverse strength of materials.* BY ROBERT H. COUSINS. New York; E. & F. N. Spon, 1889. (Octavo, 170 pages. Price, $5.)

The new theory of beams presented in this work is developed from certain "hypotheses" for which the Author offers no justification, either experimental or theoretical. Some of these hypotheses agree with those used in the common theory, and are well known as sound fundamental principles, while others, which form the real basis of the new theory, must be regarded with suspicion until the grounds upon which they rest are established. For instance, the hypothesis that "the sum of the moments of resistance of the fibers to compression is equal to the sum of the moments of resistance of the fibers to extension" is not an axiom, and hence requires explanation and demonstration. The theory of the Author cannot be regarded as "correct," unless its fundamental hypotheses are justified in some manner.

It is a fundamental principle of mechanics that when a free body is acted upon by two forces whose directions are opposite, motion will ensue unless the forces are of equal intensity. This principle, applied to the horizontal fiber strains in a beam, shows that the sum of the tensile stresses must be equal to the sum of the compressive stresses. It is scarcely possible that all the text-books could be in error in this principle, founded, as it is, upon universal experience, and yet the Author of the new theory states as one of his hypotheses that "the algebraic sum of the direct forces of compression and extension can never become zero."

The Author supposes that at the inception of the loading the neutral line or axis is at the bottom or extended side of the beam, and that as loads are added it moves upward. Reasoning from his "hypotheses" the position of the neutral line is determined, and at the time of rupture it is found to occupy a position depending upon the ratio of the ultimate tensile to the ultimate compressive strength. In this reasoning it is assumed that the hypothesis that the fiber strains are proportional to their distances from the neutral surface is true when the elastic limit of the material is exceeded.

The common theory of flexure is well estab'ished by comparing the computed and observed deflections of beams. The Author of the new theory does not, however, discuss the subject of deflection. The common theory is not a rational one for cases where the elastic limit of the material is surpassed, and when applied to the rupture of beams or columns its formulas are merely empirical. All of the formulas given by the Author should be regarded as of less value than empirical ones, because of their unsatisfactory theoretical foundation.

PRELIMINARY REPORT ON THE USE OF METAL TRACK ON RAILROADS AS A SUBSTITUTE FOR WOODEN TIES: BY E. E. RUSSELL TRATMAN, C.E. REPORT ON EXPERIMENTS IN WOOD-SEASONING BY THE CHICAGO, BURLINGTON & QUINCY RAILROAD. COMPILED BY B. E. FERNOW, CHIEF OF FORESTRY DIVISION, DEPARTMENT OF AGRICULTURE. Washington; Government Printing Office.

This pamphlet, which forms Bulletin No. 3 of the Forestry Division, is a sequel to Bulletin No. 1, issued last year by Mr. Fernow, who has, as Chief of the Division, taken an active and intelligent interest in the preservation of our forests, and who has recognized that the draft upon them for the supply of the railroad demand is one of the leading causes of their destruction.

The present report touches upon two of the chief methods of diminishing the railroad demand—the substitution of metal for wood, and the use of various processes for prolonging the life of wooden ties.

Mr. Tratman's paper is a condensed statement of what has been so far done in the use of metal abroad; for this country the statement is confined chiefly to what has been proposed, for very little has actually been done in this direction as yet.

The preservation of timber opens up a promising field, in which also there has been much more done abroad than in this country, and notes on experimental work in this direction are sure to be of service. The Forestry Division is doing excellent service, and its work should be appreciated and aided by railroad officers everywhere.

CRULL'S TIME AND SPEED CHART, FOR THE USE OF SUPERINTENDENTS, TRAINMASTERS, TRAIN-DESPATCHERS, CONDUCTORS, ENGINEERS, ETC.: BY E. S. CRULL, CHIEF TRAIN-DESPATCHER. Chicago, Ill.; Rand, McNally & Company (Price, $1).

This little book contains tables showing the time occupied to pass over a given distance at any rate of speed, from 2 up to 69 miles an hour; a separate page is given for each mile per hour, and the distance is given for each mile from 1 to 150, and also for tenths of a mile, so that the distance which a train will traverse in a given time, at almost any possible rate of speed, can be ascertained at a

glance. Such a book will be a great time-saver and exceedingly convenient in the Superintendent's office, in making up time-tables; and often more so to the Train-Despatcher, who has constant occasion to ascertain the time which special, extra, or irregular trains will take between stations at any possible rate at which they can be moved. The book deserves and will, doubtless, find a large circulation of this kind.

A HISTORY OF THE PLANING-MILL, WITH PRACTICAL SUGGESTIONS, FOR THE CONSTRUCTION, CARE, AND MANAGEMENT OF WOOD-WORKING MACHINERY: BY C. R. TOMPKINS, M.E. New York; John Wiley & Sons, No. 15 Astor Place.

The title given to this book should, perhaps, be reversed, for while 70 of its 222 pages are given up to the history of the original invention of the planing-mill and of its various improvements, and the great controversy which grew out of the Woodbury patent, the remainder is filled with very valuable and practical advice as to the construction and use of the planing-mill and other wood-working tools. The chapters under this last head include the General Construction of Machinery, Construction of Wood-working Tools, Speeding Wood-working Machinery, Adjusting New Machines, Feed-rolls, Lubrication, Moulding Machines, Difficulties of Manufacturers, Foremen and Management, Outfit for a Small Mill, Advice to Operators, Artistic Wood-work, Friction, Shafting, and Belting. In the concluding chapter there is some general and very excellent advice to young men.

Mr. Tompkins's experience of over 40 years in the construction and use of wood-working machines has enabled him to write a book which will certainly be of very great use not only to the young man beginning business, but also to the manufacturer of experience, and both classes will find in it many things that will help them.

GEOLOGICAL SURVEY OF NEW JERSEY: ANNUAL REPORT OF THE STATE GEOLOGIST FOR THE YEAR 1888. Trenton, N. J.; issued by the Survey.

This annual report is somewhat smaller than many of the preceding reports, for the reason that the geological survey is now approaching its conclusion, and the first volume of the final report has already been issued. It contains a statement of the work done by the Survey during the past year, which has been chiefly in preparing the final report and in completing the office work and maps. In addition to this statement and the usual yearly report of expenses, etc., it gives notes on the drainage of the Great Meadows in the Pequest Valley and on the drainage of the lowlands above Little Falls on the Passaic; notes on Water-Supply and Artesian Wells; a geological study of the Triassic or Red Sandstone, and statistics of the mineral products of the State for the year.

The Geological Survey of New Jersey has so high a reputation, and its publications have always reached so high a standard, that it is hardly necessary to say that the present volume is an acceptable addition to geological literature, even in the limited sphere which it necessarily covers.

BOOKS RECEIVED.

REPORT OF THE FOURTH ANNUAL MEETING OF THE ILLINOIS SOCIETY OF ENGINEERS & SURVEYORS, HELD AT BLOOMINGTON, ILL., JANUARY 23–25, 1889. Champaign, Ill.; issued by the Society, Professor A. N. Talbot, Secretary.

CATALOGUE OF INTERLOCKING APPARATUS, SIGNALS, SWITCHES, ETC., MANUFACTURED BY THE UNION SWITCH & SIGNAL COMPANY. Pittsburgh, Pa.; issued by the Company. This catalogue, or rather treatise on signals, is reserved for more extended notice hereafter.

THE MICHIGAN ENGINEERS' ANNUAL, CONTAINING THE PROCEEDINGS OF THE MICHIGAN ENGINEERING SOCIETY FOR 1889. Climax, Mich.; issued by the Society, F. Hodgman, Secretary. (Price, 50 cents.)

OCCASIONAL PAPERS OF THE INSTITUTION OF CIVIL ENGINEERS. London, England; published by the Institution. The present instalment of these papers includes the following titles: The Monte Video Water-Works, by William Galwey; Canal, River and Other Works in France, Belgium and Germany, by L. F. Vernon-Harcourt; Railway Steep Inclines, comprising four different papers by John Carruthers, Robert Wilson, Joseph P. Maxwell, and Otto Gruninger, with an abstract of the discussion on these papers; the Compound Principle Applied to Locomotives, by Edgar Worthington; Abstract of Papers in foreign transactions and periodicals.

THIRTIETH ANNUAL REPORT OF THE TRUSTEES OF THE COOPER UNION FOR THE ADVANCEMENT OF SCIENCE AND ART: 1888–89. New York; issued by the Cooper Union.

THE LOWE FEED-WATER HEATER AND PURIFIER: CATALOGUE AND DESCRIPTION. St. Louis; issued by the Pond Engineering Company. This catalogue gives a description of the Lowe feed-water heater, which has been in use for a number of years, and has been widely introduced through the West. It sets forth concisely the advantages of the heater, with the best method of using it. The Pond Engineering Company are the Western agents of this device.

ILLUSTRATED CATALOGUE OF WOOD-WORKING MACHINERY, Rochester, N. Y.; J. S. Graham & Company. This catalogue deserves especial mention for the excellence of the engravings and the completeness of the descriptions. It gives accounts of a large variety of tools manufactured by this well-known firm.

STEAM-PUMPING MACHINERY BY THE BUFFALO STEAM PUMP COMPANY: CATALOGUE AND DESCRIPTION. Buffalo, N. Y.; issued by the Company. This is a well-illustrated catalogue of their large variety of pumping-machines, and in addition has a compendium of information useful for persons who require steam pumps.

THE CONTRACTORS' PLANT MANUFACTURING COMPANY: CATALOGUE No. 3, 1889. Buffalo, N. Y.; issued by the Company. This catalogue gives a very full list of hoisting machinery, derricks for steam, horse and hand power, contractors' plows, road-rollers, dumping-cars and similar machinery made by the Company.

THE ACME AUTOMATIC SAFETY ENGINE: CATALOGUE AND DESCRIPTION. Rochester, N. Y.; the Rochester Machine Tool Works, Limited.

THE CONSTRUCTION AND USE OF THE UNIVERSAL HAND LATHE. Providence, R. I.; issued by the Brown & Sharpe Manufacturing Company.

DAVIS DRILLS AND KEY-SEATING MACHINES: CIRCULAR AND DESCRIPTION. Rochester, N. Y.; W. P. Davis, 169–171 Mill Street.

THE STANDING AND RECORD OF THE HEISLER SYSTEM OF LONG DISTANCE INCANDESCENT ELECTRIC LIGHTING. St. Louis, Mo.; issued by the Heisler Electric Light Company.

WILL STEAM-HEATED HOT WATER HEAT RAILROAD CARS? THE MCELROY APPARATUS FOR HEATING CARS. Albany, N. Y.; issued by the McElroy Car-Heating Company.

THE ERIE CAR-HEATING COMPANY: CATALOGUE AND DESCRIPTION. Erie, Pa.; issued by the Company. This is a clear and well-illustrated description of the system of steam heat-

ing introduced by the Company, which has been tried on the Lake Shore & Michigan Southern and the Pittsburgh, Fort Wayne & Chicago roads with very satisfactory results.

The Gould Manufacturing Company's Catalogue of Pumps and Hydraulic Machinery: Twenty-seventh Edition, 1889. Seneca Falls, N. Y.; issued by the Company.

Rogers' Patent Shaking and Dumping Grate Bar. Utica, N. Y.; H. Rogers.

The Ferguson Boiler for Steam and Hot Water Heating. Albany, N. Y.; issued by the Ferguson Boiler Company.

The Button Steam Fire Engine. The Button Hand Fire Engine: Catalogues and Descriptions. Waterford, N. Y.; issued by the Button Fire-engine Company, Holroyd & Company, Proprietors.

The Petithomme Dust-Guard and Car-Axle Box: Catalogue and Description. Oakland, Cal.; issued by Joseph L. Petithomme.

ABOUT BOOKS AND PERIODICALS.

The Journal of the Engineers' Society of Lehigh University for April has articles on Fuel Gas and a Graphical Solution of a Valve Gear Problem, besides the proceedings of the Society and a number of other notes of interest to the Alumni of the University.

Among the articles in the Stevens Indicator for April are papers on the Design of Locomotive and Car Springs; the Features of English Locomotive Practice, and the Inspection of Riveted Bridge Work, besides several others of value. An Electric Railroad Power Test gives a careful account of the power employed and the operating expenses of the electric railroad at Asbury Park, including some particulars of the operation which are not always easy to get from our electrical brethren.

Recent issues of the D. Van Nostrand Company, New York, include Machine-Drawing and Design, by William Ripper, a very elaborate work on this subject, upon which, by the way, many books have been published, but very few of any lasting value. Another recent work is Waring on Sewers and Sewerage, a book by one of the highest authorities now living. Recent issues of the Science Series, published by this Company, include Leveling, by Professor Baker; Recent Practice in Sanitary Drainage, by William Paul Gerhard; the Treatment of Sewage, by Dr. C. M. Tidy, and a revised edition of Redwood on Petroleum. This firm is now issuing a number of books on electrical engineering.

The first of the Electrical Papers in Scribner's Magazine appears in the June number; it is by C. F. Brackett, and is chiefly introductory, giving an outline of the subject and a sketch of the ground to be covered by this series. This is extensive enough, and will take some time even in the popular form proposed.

The chapter of Mr. Kennan's Siberian Travels in the Century for June treats of the gold mines of Kara, which are rich enough to tempt immigration, if it were not for the fact that the Imperial ownership of the mines and the convict system shut out all outside enterprise, and probably will continue to do so even when the railroad renders the mines accessible. A note on Forestry and Forest Preservation in the same number will be read with interest.

The paper on the Historical Capital of Iowa, by Mrs. Dye, in the Magazine of American History for June, deals incidentally with the many and great changes made in the West, by the progress of railroads. But it may be a question whether Iowa City has not done better service as the educational capital of the State, and the seat of the State University, than it would have done had it remained simply the political capital.

One magazine must be considered as having—perhaps not intentionally—discouraged railroad travel. In Outing, for June, the pleasures and advantages of journeying on horseback, by bicycle, and by canoe are set forth so attractively as to tempt the reader to give up the railroad at once, for one or all of these more athletic modes of travel.

In California just now there is no more interesting question than that of irrigation, and an article on that subject by John Bonner, in the June number of the Overland Monthly, will attract attention. It is a clear statement of the necessity of some intelligent control of the question to prevent the waste of resources, which must be carefully husbanded, if they are to be properly utilized. The plan for the regulation of the matter by the general Government is a fair one, but it is doubtful whether the people—on the Atlantic coast at least—are yet ready to have the Government undertake the expense of extensive irrigation works at present, however necessary they may be to the local prosperity of the Pacific slope.

Something of the feeling which exists there and of the irritation which is sometimes caused by Eastern ignorance and apparent want of interest finds expression in another article in the same number on a Pacific Coast Policy, the writer of which is, perhaps, inclined to put his case rather strongly, but which nevertheless deserves reading.

In Harpers' Magazine for July there is an interesting article on Glass Manufacture, profusely illustrated.

In the Popular Science Monthly for June Mr. Almy's paper on the Production of Beet Sugar has much to say of the machinery used in that industry, which is interesting to a mechanical engineer. An article by Dr. Zacharias on the Animals Found in Well Water deserves careful reading by the sanitary engineer. In the July number is an article on Railroad Maladministration, by Benjamin Reece, treating of the over-building of railroads, with the consequent loss either to investors or the public.

UNITED STATES NAVAL PROGRESS.

The Navy Department has issued proposals for the three 2,000-ton cruisers, the plans for which are described below. Four classes of bids were asked for:

1. For a vessel in accordance with the plans of the Department for both hull and machinery.
2. For a vessel to be built on plans, for both hull and machinery, to be furnished by the contractors.
3. For a vessel, the contractor to furnish plans for the machinery, the hull to be built on plans of the Department.
4. For a vessel, the contractor furnishing plans for the hull and using the Department plans for the machinery.

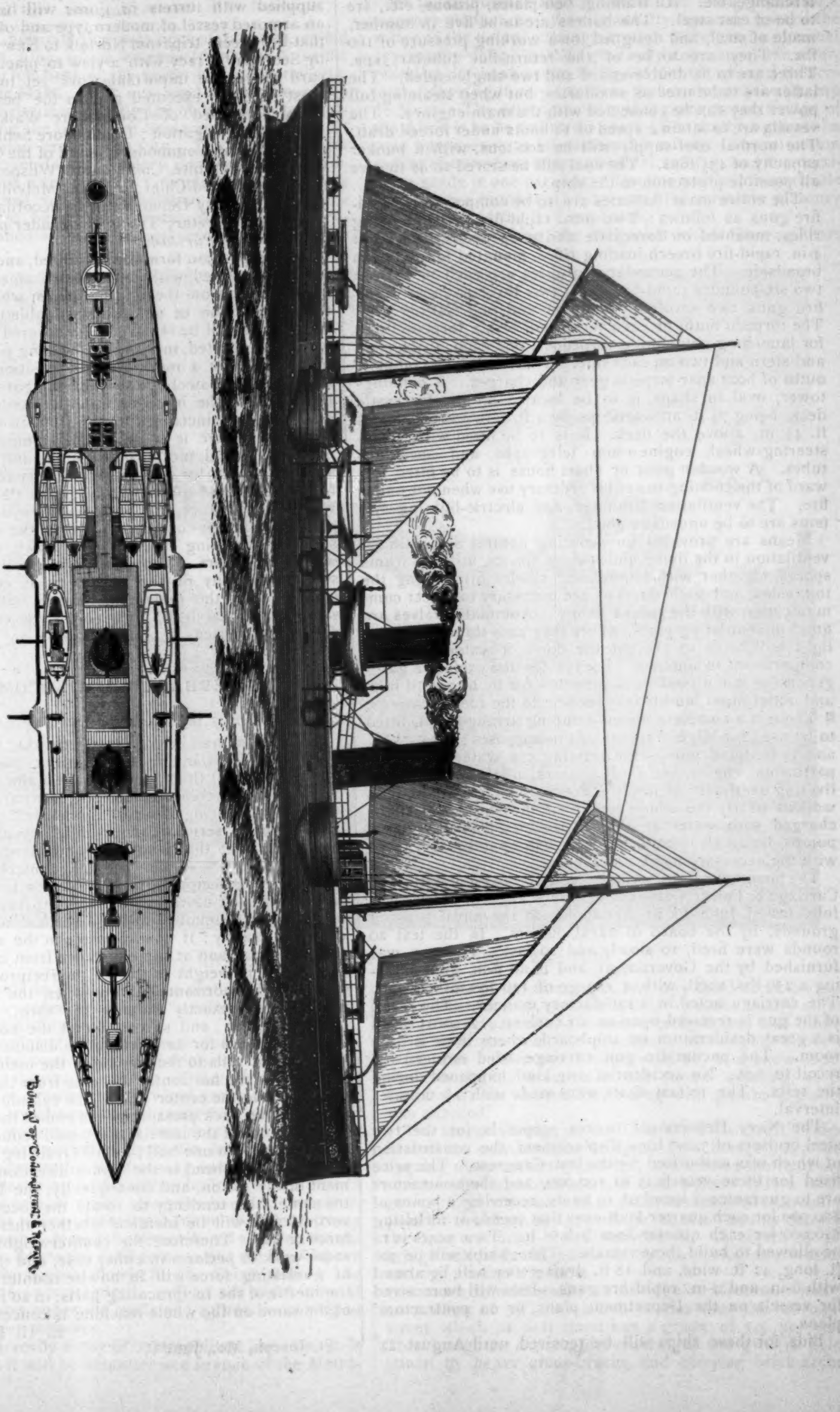
The bids will be received until August 22, 1889. The cost of these vessels is limited by law to $700,000 each.

The accompanying illustration, for which we are indebted to the *Army and Navy Register*, shows a side-view and deck plan of the new 2,000-ton cruisers, for which plans have been prepared. These vessels were described in the June number of the Journal, but for convenience the description is here partially repeated.

The chief dimensions are: Length on load water-line, 257 ft.; extreme breadth, 37 ft.; depth of hold to under side of spar-deck amidships, 19 ft. 6 in.; mean normal draft, 14 ft. 6 in.; displacement to load water-line, 2,000 tons; tons per inch at load water-line, 15½; area of immersed midship section, 665 sq. ft.; transverse metacenter, 7 ft. above center of gravity.

These vessels are to be twin-screw, protected cruisers with poop and forecastle decks and open-gun decks between, fitted with water-tight decks of 17½ lbs. plating at sides, reduced to 12 lbs. in the center, extending the entire length of the vessels. This deck is to be below the water-line at the sides 36 in., and all the machinery, magazines, and steering apparatus are to be below it. The rig is to be that of a two-masted schooner, bearing a small spread of canvas.

The motive power for each vessel is to be furnished by



DESIGN FOR NEW 2,000-TON CRUISERS, UNITED STATES NAVY.

two triple-expansion engines of 5,400 H.-P., with cylinders of 26½, 39, and 63 in. in diameter and 33 in. stroke. The engines and boilers are to be placed in separate water-tight compartments. The crank-shafts are to be made interchangeable. All framing, bed-plates, pistons, etc., are to be of cast steel. The boilers are to be five in number, made of steel, and designed for a working pressure of 160 lbs. They are to be of the return-flue tubular type. Three are to be double-ended and two single-ended. The latter are to be used as auxiliaries, but when steaming full power they can be connected with the main engines. The vessels are to attain a speed of 18 knots under forced draft. The normal coal-supply will be 200 tons, with a bunker capacity of 435 tons. The coal will be stored so as to give all possible protection to the ship.

The entire main batteries are to be composed of rapid-fire guns as follows: Two 6-in. rapid-fire breech-loading rifles, mounted on forecastle and poop decks, and eight 4-in. rapid-fire breech-loading rifles, mounted four on each broadside. The secondary batteries are each to contain two six-pounder rapid-fire guns, two three-pounder rapid-fire guns, two revolving cannons, and one Gatling gun. The torpedo outfit of each vessel will be six torpedo tubes for launching automobile torpedoes, one each at the stem and stern and two on each side. There will be a complete outfit of boat spar-torpedo gear and charges. A conning-tower, oval in shape, is to be located on the forecastle deck, being 7½ ft. athwartships by 4 ft. fore and aft, and 5 ft. 4½ in. above the deck. It is to be fitted with steam steering-wheel, engine-room telegraphs and speaking-tubes. A wooden pilot or chart-house is to be fitted forward of the conning-tower for ordinary use when not under fire. The ventilation, drainage, and electric-lighting systems are to be unusually good.

Means are provided for securing natural and artificial ventilation in the living and storage spaces, utilizing frame spaces, together with louvres and cowles fitted along the top, sides, and such ducts as are necessary to effect communication with the spaces below. Automatic valves are fitted in ventilating pipes, where they pass through water-tight bulkheads to prevent the flood of water from one compartment to another. Escape for the explosive gases generated in the bunkers is provided for by means of inlet and outlet pipes, and trunks leading to the funnel casings.

There is a complete steam-pumping arrangement, fitted to be used for bilge drainage or fire purposes; also, 7½-in. and 5½-in. hand pumps for draining the water-tight compartments, engine and shaft bearers, platforms, etc., delivering overboard or into the fire-main. The fire-main is worked nearly the whole length of the ship, and can be charged with water at a high pressure from the steam pumps, being also connected with hand pumps, and fitted with the necessary nozzles and hose.

The pneumatic gun carriage, made by the Pneumatic Gun Carriage & Power Company of South Boston, Mass., was fully tested June 12, at Annapolis, at the naval proving grounds, by the board of naval officers. In the test 20 rounds were fired, 10 slowly and 10 fast. The gun was furnished by the Government, and is an 8-in. gun, carrying a 250-lbs. shell, with a charge of 126 lbs. of powder. The carriage acted in a satisfactory manner. The recoil of the gun is received upon an air cushion. A short recoil is a great desideratum on shipboard, where there is little room. The pneumatic gun carriage tried reduced the recoil to 2 ft. No accident of any kind happened during the tests. The 10 fast shots were made with 1½ minutes interval.

The Navy Department invites proposals for the two steel cruisers of 3,000 tons displacement, the construction of which was authorized by the last Congress. The price fixed for these vessels is $1,100,000, and the contractors are to guarantee a speed of 19 knots, receiving a bonus of $50,000 for each quarter-knot over that speed, or forfeiting $50,000 for each quarter-knot below it. Two years is to be allowed to build these vessels. These ships will be 300 ft. long, 42 ft. wide, and 18 ft. draft; they will be armed with 6-in. and 4-in. rapid-fire guns. Bids will be received for vessels on the Department plans, or on contractors' plans.

Bids for these ships will be received until August 22. The time for receiving bids for the 2,000-ton cruisers has been fixed at the same date, August 22 next.

It is probable that the monitor *Puritan*, which for years has been a monitor only in name, never having been supplied with turrets or guns, will be transformed into an armored vessel of modern type and of great power, and that her recent trip from Norfolk to New York was ordered by Secretary Tracy with a view to placing the vessel in a yard where the important work yet to be done can be most speedily executed and to the best advantage. A board composed of Commodore Walker, Chief of the Bureau of Navigation; Commodore Schley of the Bureau of Equipment, Commodore Sicard of the Ordnance Bureau, Commodore White, Commodore Wilson of the Construction Bureau, and Chief Engineer Melville has been in session at the Navy Department, in accordance with instructions from Secretary Tracy, to consider plans for the completion of the *Puritan*.

The proposition formally submitted, and which will probably be accepted without extensive amendments, departs considerably from the original plans, which contemplated the construction of an ordinary double-turreted monitor. The turrets will be replaced with covered barbettes. This will, it is expected, increase the fighting power of the guns, by giving them a more elevated position, while the permanent wall of steel above which the guns revolve will not be subject to the influx of water as would a turret. The guns are to be increased in size from 10 to 12 in. caliber; a superstructure is to be erected amidships, which will make the vessel more comfortable, and which will also serve as a basis for a secondary battery of powerful rapid-fire and machine guns. To allow for this increase in the weight of ordnance, it is proposed to reduce the thickness of the armor belt considerably below the water-line, while slightly increasing its thickness above, and to dispense with two boilers. This last change would not affect the steaming ability of the vessel, as it contemplates the equipment of the remaining boilers with apparatus for supplying forced draft, thus more than making good the deficiency caused by the reduction in the number of boilers.

COUNTERBALANCING LOCOMOTIVES.

To the Editor of the Railroad and Engineering Journal:

IN the June number of your JOURNAL, in an article entitled Counterbalancing Locomotives, the writer states: "No one will, I think, question that the resisting forces (back-pressure, compression, and lead) are prime factors in counterbalancing an engine properly." I do, however, question most seriously the truth of the above statement, and claim that the propelling and resisting forces have nothing whatever to do with the counterbalancing of the inertia of the reciprocating parts of a locomotive. The tendency of the aforesaid inertia is to revolve the entire mass of the locomotive about a vertical axis through its center of gravity; if now we place in the wheel, opposite the crank-pin, and at same distance from center of axle, a mass equal in weight to that of the reciprocating parts on that side, its horizontal throw when the crank is on its center would exactly balance the throw of the piston, cross-head, etc., and so counteract the nosing tendency. This inertia has for its leverage the distance from midway between the rails to the middle of the main-rod crank-pin bearing, or the horizontal distance from the center line of the engine to the center line of the cylinder. If now, for example, the back pressure at the end of the stroke should be equal to half the inertia, this would reduce the pressure on the crank-pin one-half; but this resisting force also acts on the cylinder head in the same direction as the movement of the piston, and consequently, the leverage being the same, the tendency to rotate the locomotive about a vertical axis will be identical whether there is a resisting force or not. Therefore the counterweight will have the same work to perform in either case, and the introduction of a resisting force will in nowise counteract any part of the inertia of the reciprocating parts, in so far as the effect of the same on the whole machine is concerned.

E. H. DEWSON, JR.

St. Joseph, Mo., June 6.

A PARIS SUBURBAN LINE.

(Condensed from *Le Genie Civile.*)

ON May 1 a new city line was opened in Paris, called the Moulineaux Line, which extends from a point in the suburbs, on the left bank of the Seine, just above the city, to the Champ de Mars. This new road is a section of the line which is to run from the Bridge of the Alma to Courbevoie, following the line of the Seine and forming a sort of horse-shoe road around the city. The concession for the line was given to the Western Railroad Company in 1875, and in 1878 a section from Grenelle to the Champ de Mars was opened, but the completion of the rest of the road was delayed by various causes. The original location was modified in many places, and work was really politan Road, which is to be built in Paris, if an agreement can ever be reached as to the line to be adopted.

The Moulineaux Line leaves the Versailles Railroad close to the Puteaux Station, crosses the low grounds on a masonry viaduct, and then gradually descends toward the valley of the Seine, passing through Suresnes by a tunnel 335 meters long; it then gradually approaches the river, reaching its bank at the Bridge of St. Cloud, and thenceforth following it very closely to the terminus at the Champ de Mars. The extension from that point to the Bridge of the Alma is to be built next year. The total length of the road now open is 14 kilometers (8.7 miles). The minimum radius of curvature is 350 meters (1,148 ft.), and the maximum grade is one per cent. The line is chiefly remarkable for the large number of bridges and the extensive masonry works required for its completion.

Generally speaking, the obligation which the engineers

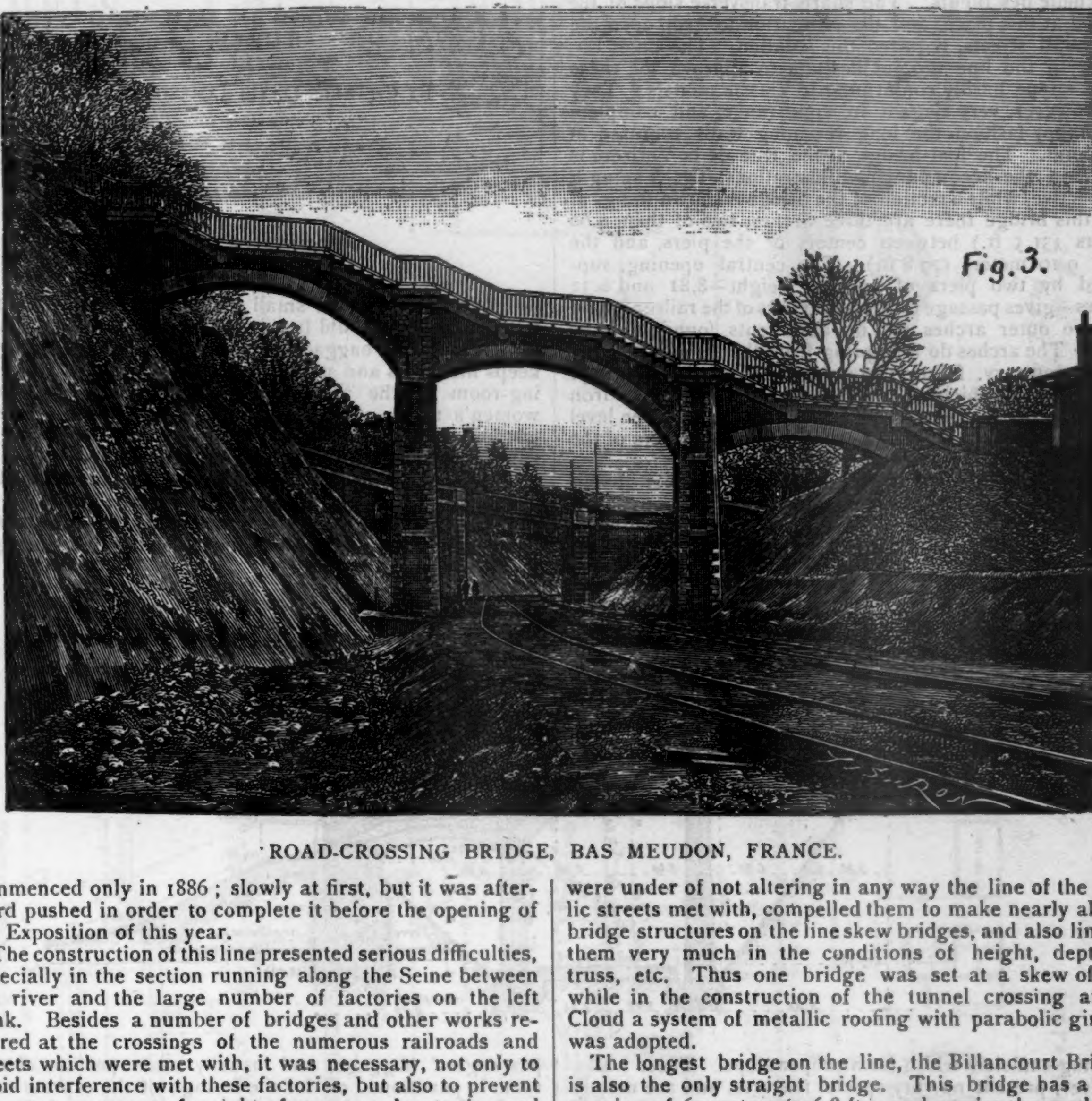


Fig. 3.

ROAD-CROSSING BRIDGE, BAS MEUDON, FRANCE.

commenced only in 1886; slowly at first, but it was afterward pushed in order to complete it before the opening of the Exposition of this year.

The construction of this line presented serious difficulties, especially in the section running along the Seine between the river and the large number of factories on the left bank. Besides a number of bridges and other works required at the crossings of the numerous railroads and streets which were met with, it was necessary, not only to avoid interference with these factories, but also to prevent too great an expense for right-of-way, to so locate the road as to avoid interfering with existing buildings, and thus to occupy a very narrow space along the bank of the river. In three places it was necessary to tunnel in order to carry the road through. It must be remembered also that the engineers had to locate the road so as to put the track above the level of the highest floods in the Seine, taking the freshet of 1876 as a standard, and, at the same time, if possible, to pass under the roads and railroads running to the bridges over the river.

The line is really a city or metropolitan line, and it is probable that it will be hereafter one branch of the Metro- were under of not altering in any way the line of the public streets met with, compelled them to make nearly all the bridge structures on the line skew bridges, and also limited them very much in the conditions of height, depth of truss, etc. Thus one bridge was set at a skew of 28°, while in the construction of the tunnel crossing at St. Cloud a system of metallic roofing with parabolic girders was adopted.

The longest bridge on the line, the Billancourt Bridge, is also the only straight bridge. This bridge has a total opening of 60 meters (196.8 ft.), and carries the road over several streets, which meet at that point. It is a lattice girder in three spans, and in order to diminish as much as possible the depth of the girders, the cross-beams carrying the floor rest upon the lower chords. A sketch of this bridge will be found herewith, fig. 1 showing an elevation, and fig. 2 a cross-section.

A more difficult work was a bridge at Meudon, which is on a skew of 35°, and which carries over the railroad a street which at that point has a grade of 5.5 per cent. This bridge is a plate-girder bridge, the girders being joined by heavy cross-braces, and carrying brick arches

upon which the roadway is supported. The sharp skew of this bridge required a very careful and detailed study

Fig. 1.

Fig. 2.

of the abutments, in order to get at the shape of the large stones at the angles.

Among the masonry works on this line are two which are altogether original. These are two foot-bridges, or rather stairways, thrown across the railroad at Bas-Meudon, carrying two small streets, the Rue de la Verrerie and the Ruelle des Bœufs. The sharp transverse slope of the ground at this place, and the obligation to keep open the two small streets, required this solution. The Chief Engineer of the line did not hesitate to approve for these works a type hardly conforming to classic models. They are, however, very elegant in appearance, and complete in a happy fashion the long retaining walls required at that point. The foot-bridge at the Rue de la Verriere is shown in the accompanying illustrations, fig. 3 being a perspective, while a section of the bridge is shown in fig. 4.

In this bridge there are three arches, two of them 9.60 meters (31.5 ft.) between centers of the piers, and the third 9.10 meters (29 8 ft.). The central opening, supported by two piers of unequal height—8.81 and 6.32 meters—gives passage to the two tracks of the railroad, and the two outer arches rest on abutments founded on the bank. The arches do not spring from the same level, but, on the contrary, follow the general fall of the roadway. The foot-way, which is provided on each side with an iron railing, is in the form of staircases, divided by three level sections corresponding respectively to the centers of the three arches.

The other works on this line include a number of very heavy retaining walls, which were needed at different points on account of the light nature of the soil in the neighborhood of the river, and the impossibility at several points of

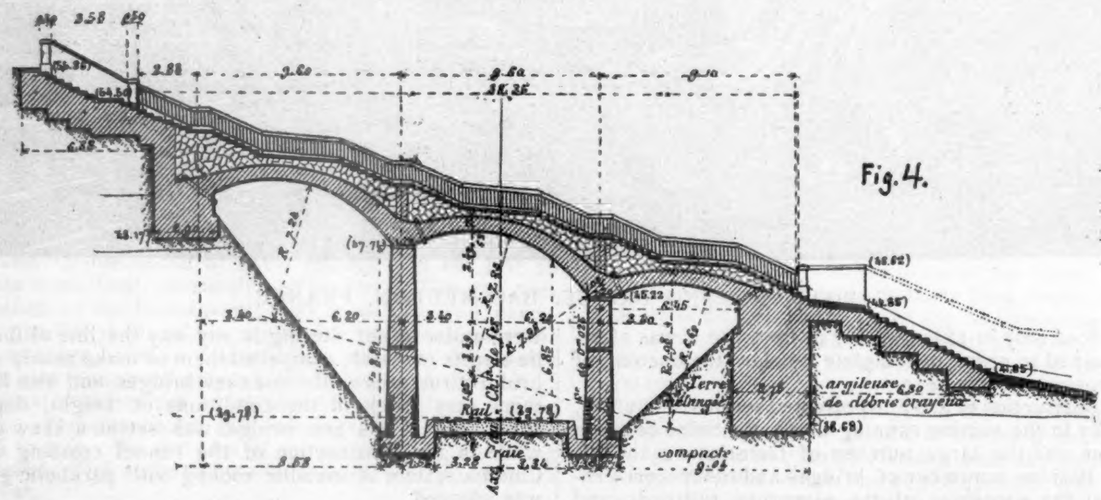


Fig. 4.

securing sufficient width for a proper slope. These walls, however, present no very special features, and are merely remarkable for their extent and cost.

The stations on the line also, while involving considerable expense for their construction, and while they are, like most of the Paris stations, solid and elegant buildings, present no features requiring special notice.

There were necessarily made on the line several grade crossings of streets at points where they could not be avoided; these grade crossings are all provided with watchmen and with gates worked in the usual way by hand, with the exception of the crossing of the Avenue Eugenie at St. Cloud, where there are rolling gates worked from a distance by wire ropes; these gates are kept in equilibrium by counterbalanced weights in such a way as to require a very small expenditure of power to move them.

The location of the line and the design of the works was due principally to M. Lecomte, Chief Engineer of the Western Railroad, and the road was built under the immediate direction of M. Clerc, Chief Engineer of Construction for that Company.

THE USE OF WOOD IN RAILROAD STRUCTURES.

By Charles Davis Jameson, C. E.

(*Continued from page 283.*)

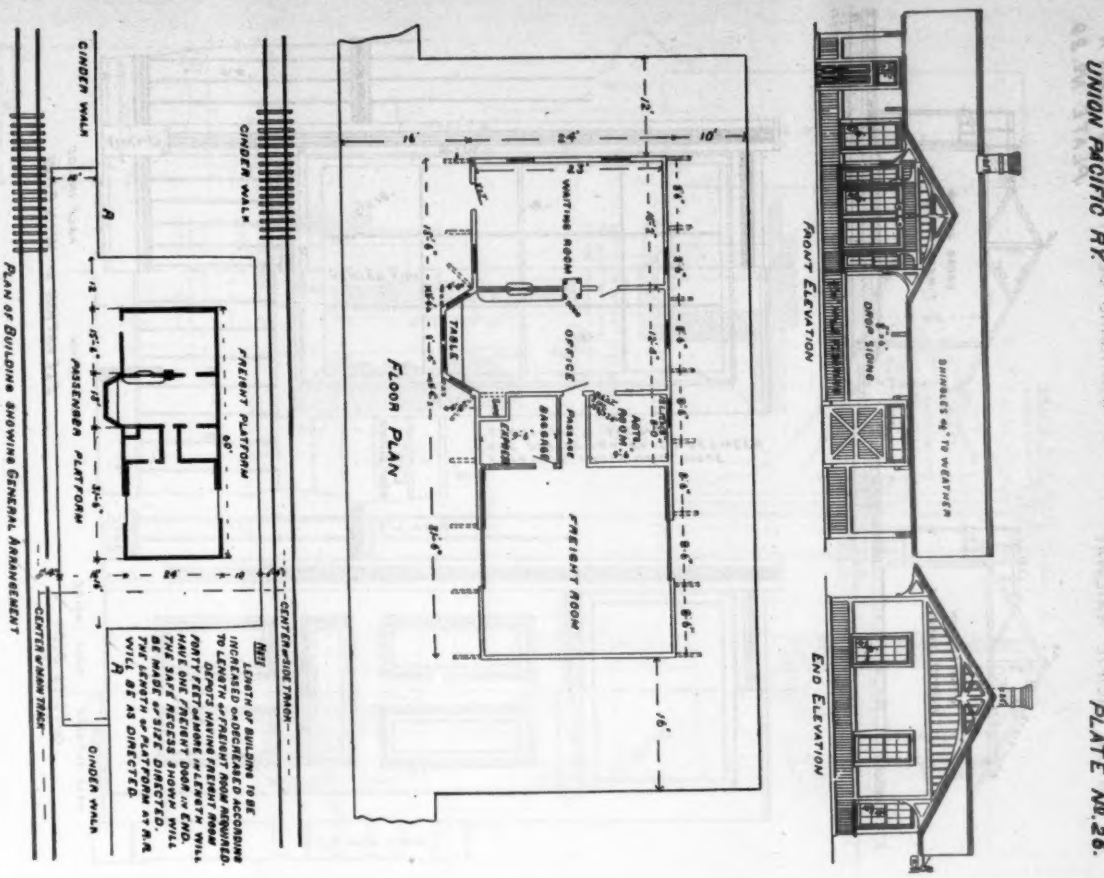
CHAPTER XI.

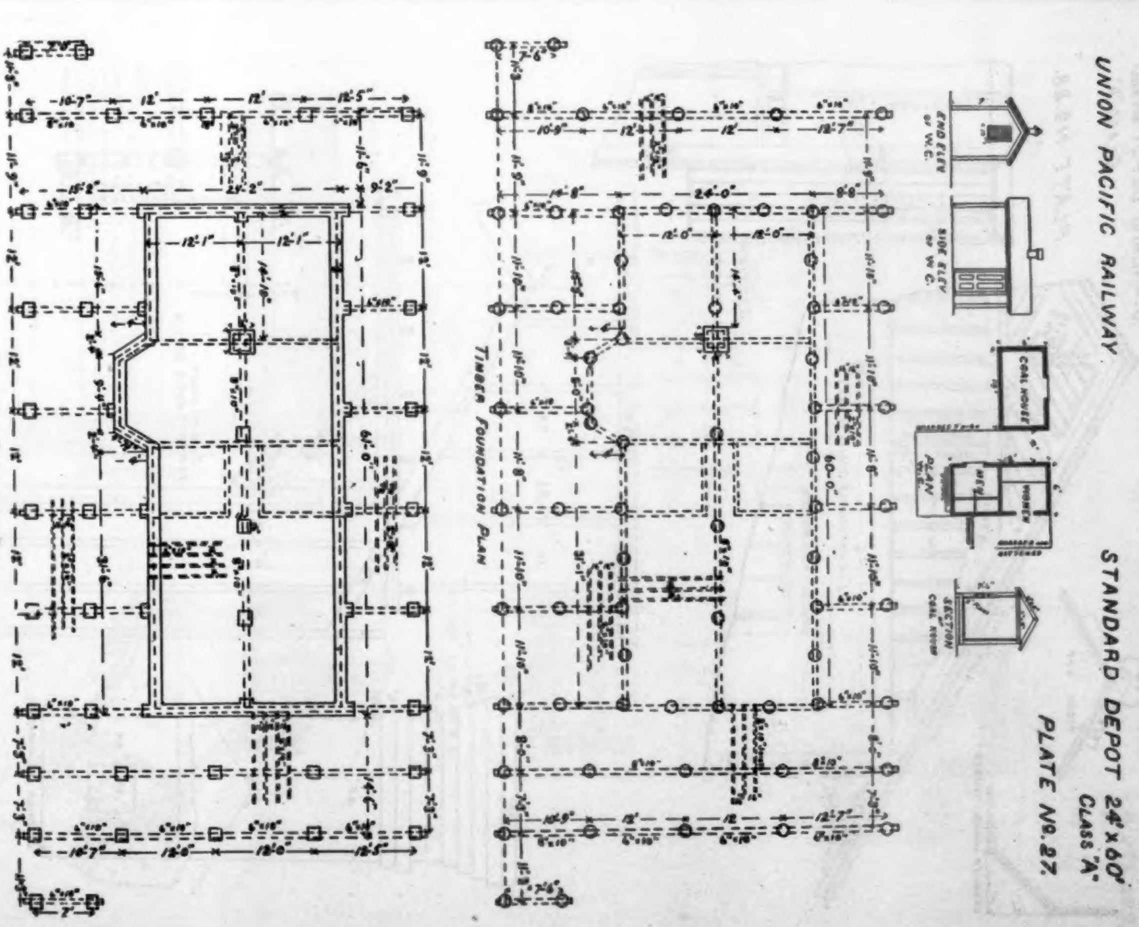
SMALL STATIONS.

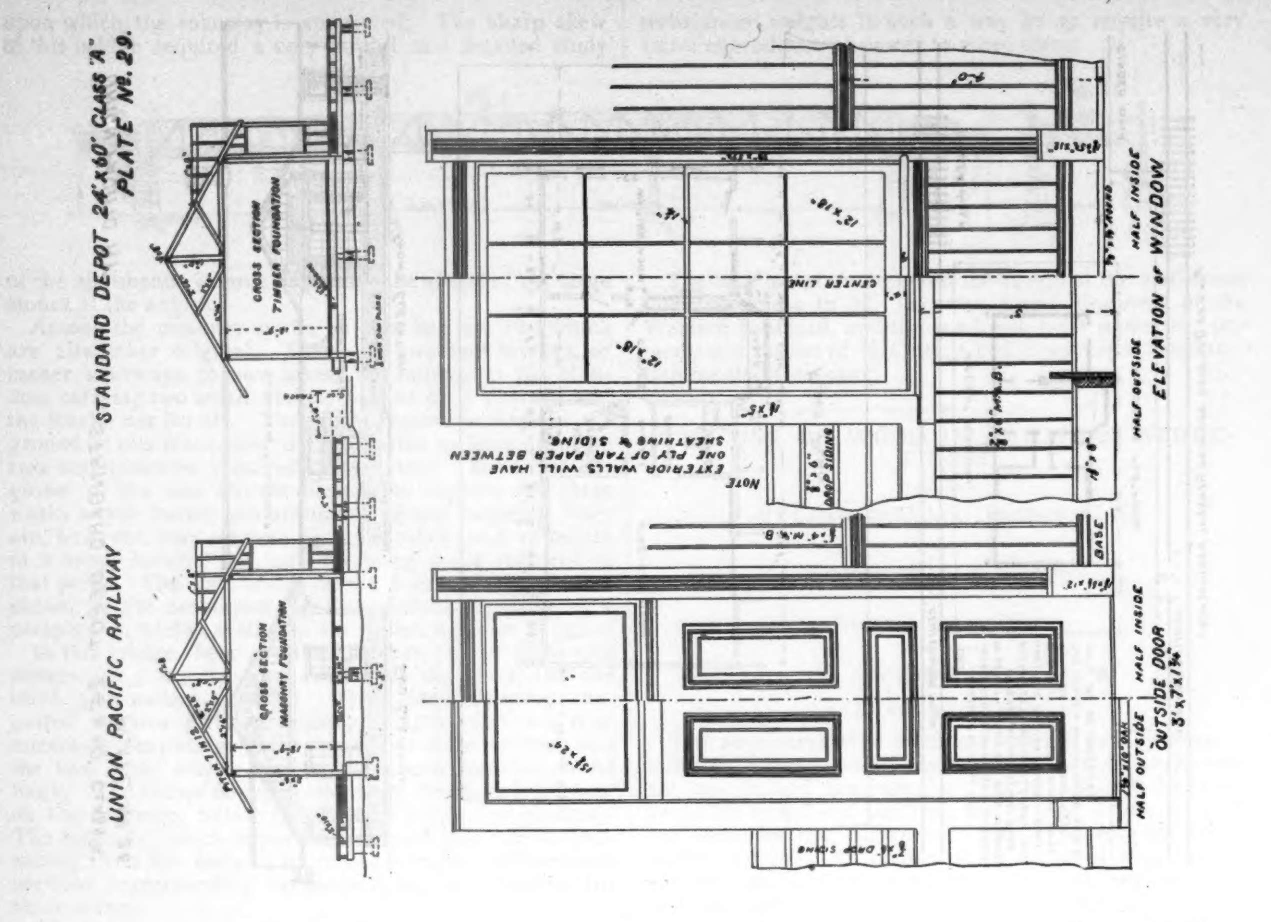
The requirements of small stations are usually about as follows: There should be one large room that can be used for freight and baggage; an office in which the agent keeps his books and performs his clerical duties; a waiting-room for the accommodation of passengers, and a women's toilet. Of course these different requirements can be contracted or expanded to almost any degree, to suit the special requirements of any one station.

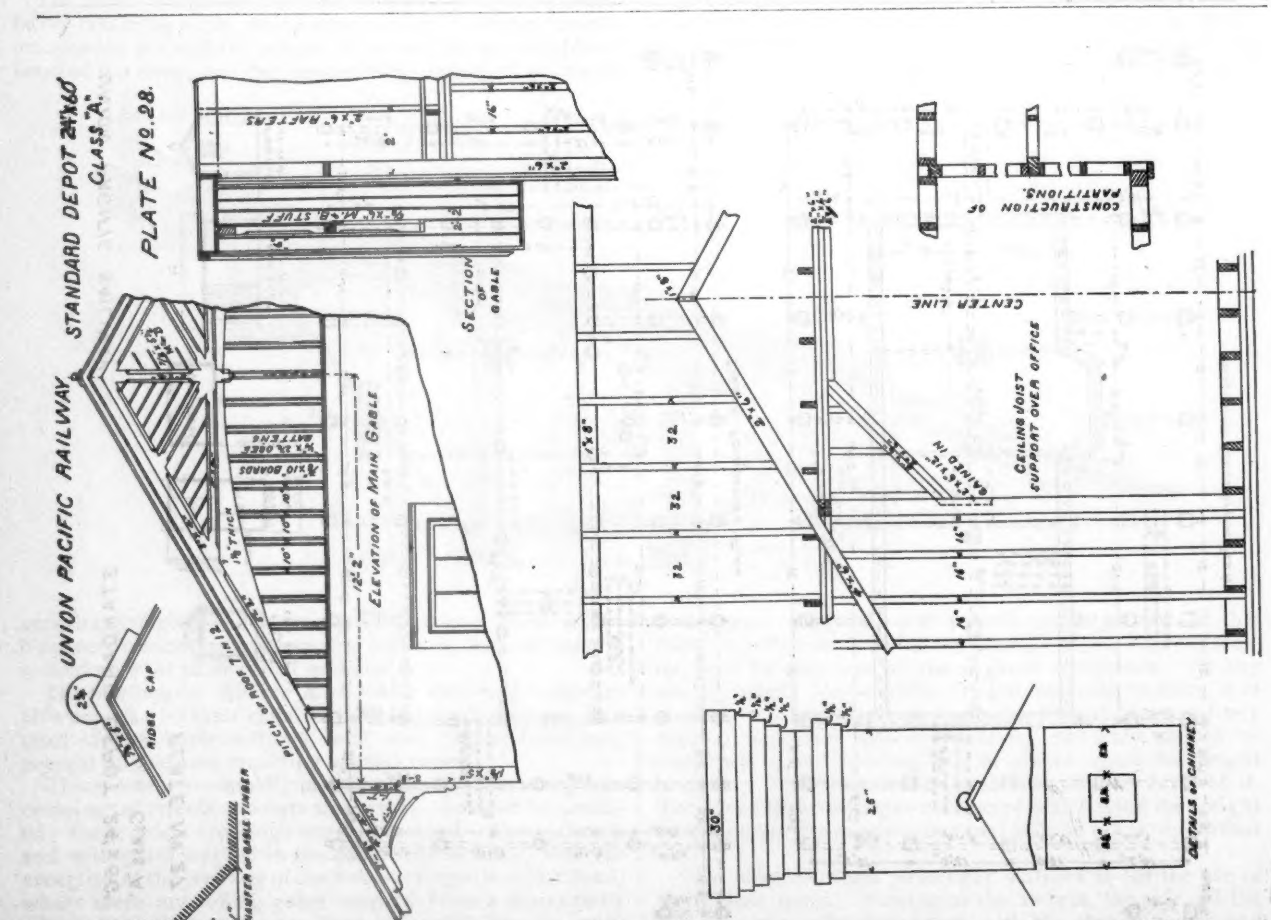
The freight-room is required for storing the freight that is received for sending away, and also that which is awaiting delivery at the place where the station is. It must also be of sufficient size to allow the receiving and storing of passengers' baggage, and usually some portion of this room is partitioned off for the storage of the express matter, and for the use of the express companies. At any station where considerable freight business is done, it is in every way preferable to have the freight-house entirely distinct from the passenger station, and they should be combined in one building only at places where the freight is of very little importance, and there is very little of it. The many disadvantages connected with having the freight and baggage-room under one roof will be taken up further on.

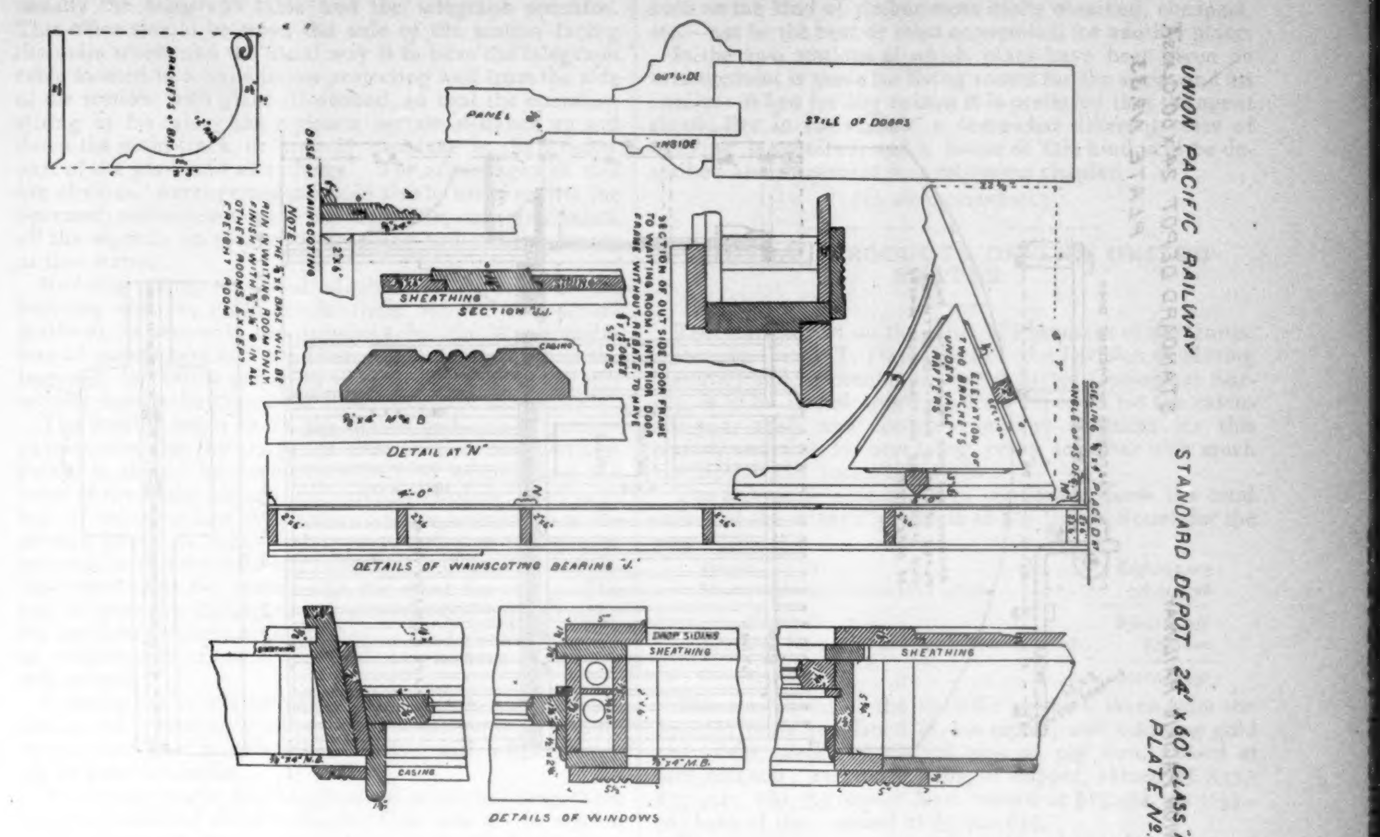
The office of these passenger stations is for the use of the station agent. It contains the tickets, the safe, all the papers and books connected with his clerical work, and

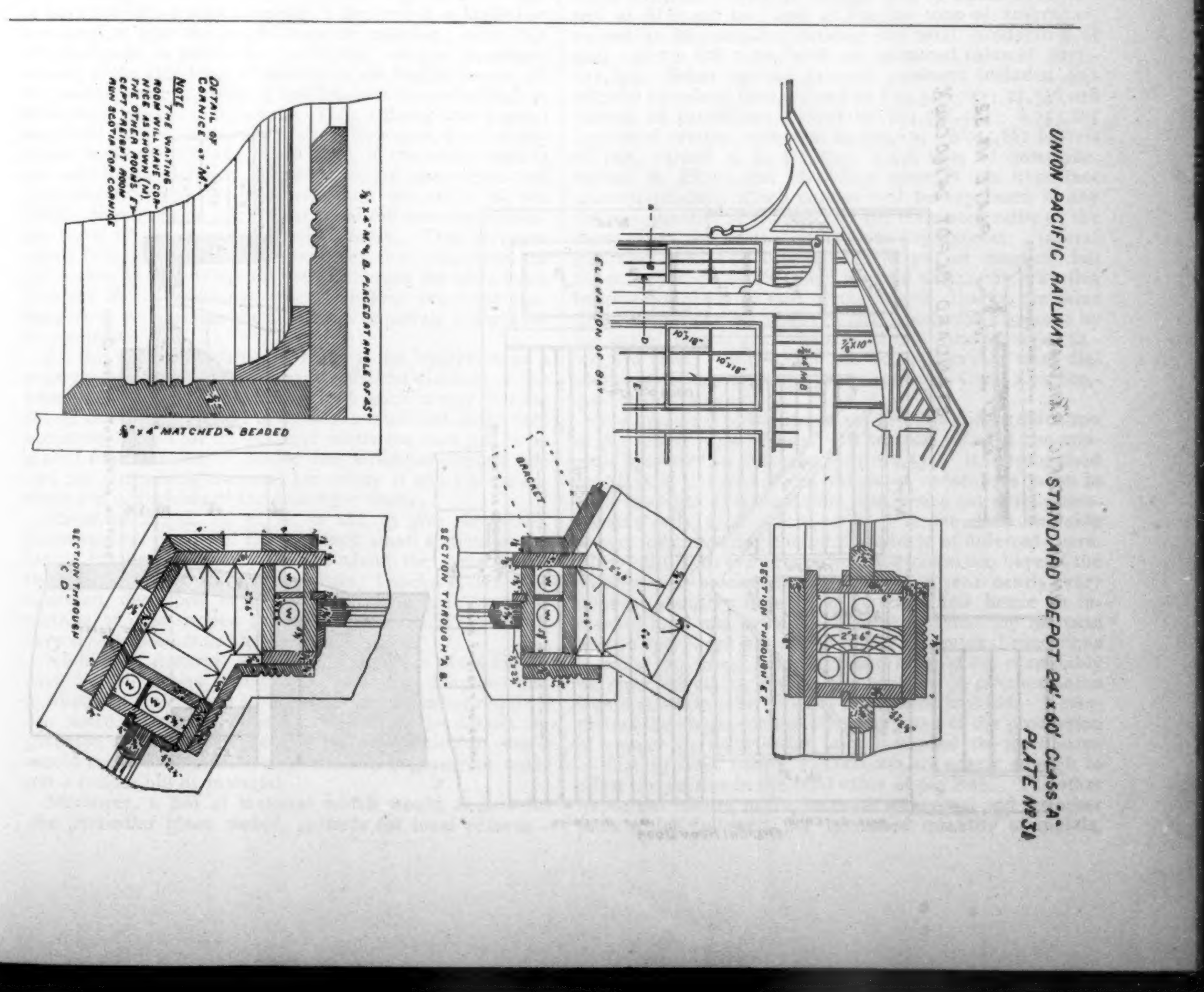

UNION PACIFIC RY.
STANDARD DEPOT 24' x 60' CLASS "A"
PLATE No. 26.
FRONT ELEVATION
END ELEVATION
DROP SIDING
FLOOR PLAN
WAITING ROOM
OFFICE
FREIGHT ROOM
TABLE
CINDER WALK
FREIGHT PLATFORM
PASSENGER PLATFORM
CENTER OF SIDE TRACK
CENTER OF MAIN TRACK
PLAN OF BUILDING SHOWING GENERAL ARRANGEMENT

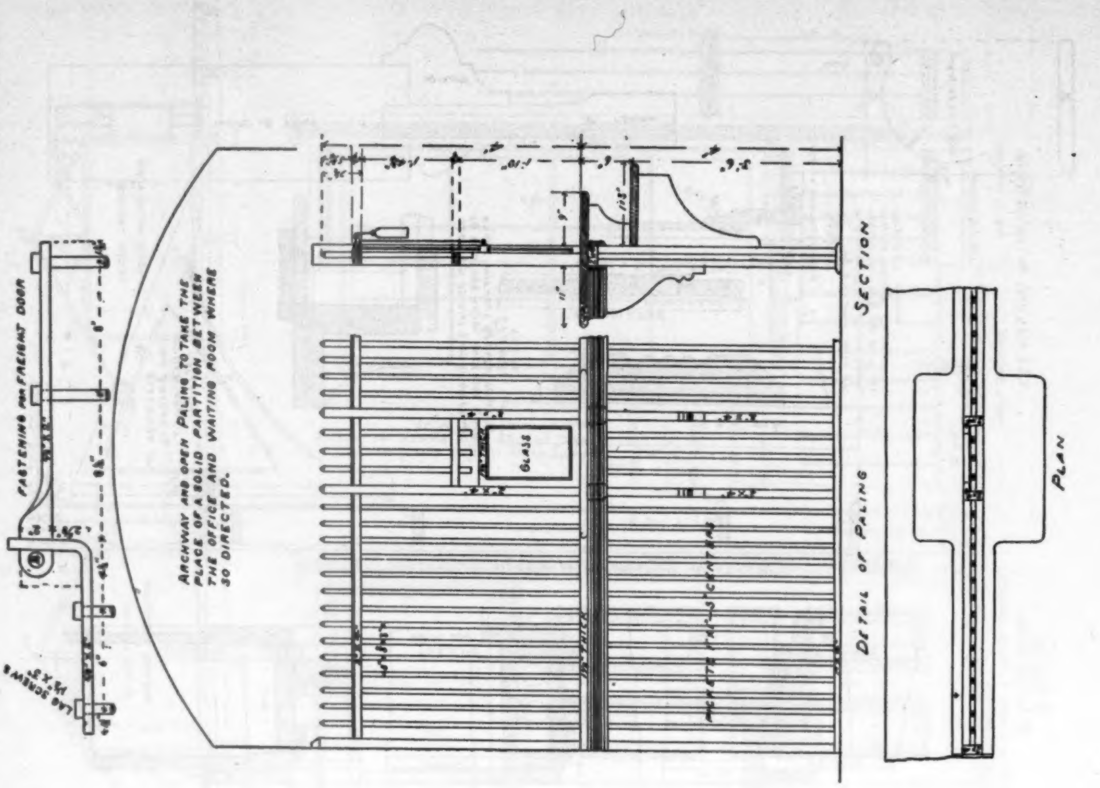

UNION PACIFIC RAILWAY
STANDARD DEPOT 24' x 60' CLASS "A"
PLATE No. 27.
END ELEV. OF W.C.
SIDE ELEV. OF W.C.
COAL HOUSE
TIMBER FOUNDATION PLAN
MASONRY FOUNDATION PLAN


UNION PACIFIC RAILWAY
STANDARD DEPOT 24'x60' CLASS "A"
PLATE No. 29.
CROSS SECTION
MASONRY FOUNDATION
CROSS SECTION
TIMBER FOUNDATION
NOTE
EXTERIOR WALLS WILL HAVE
ONE PLY OF TAR PAPER BETWEEN
SHEATHING & SIDING.
DROP SIDING
CENTER LINE
BASE
HALF OUTSIDE
HALF INSIDE
OUTSIDE DOOR
3'x7'x1¾
HALF OUTSIDE
HALF INSIDE
ELEVATION OF WINDOW

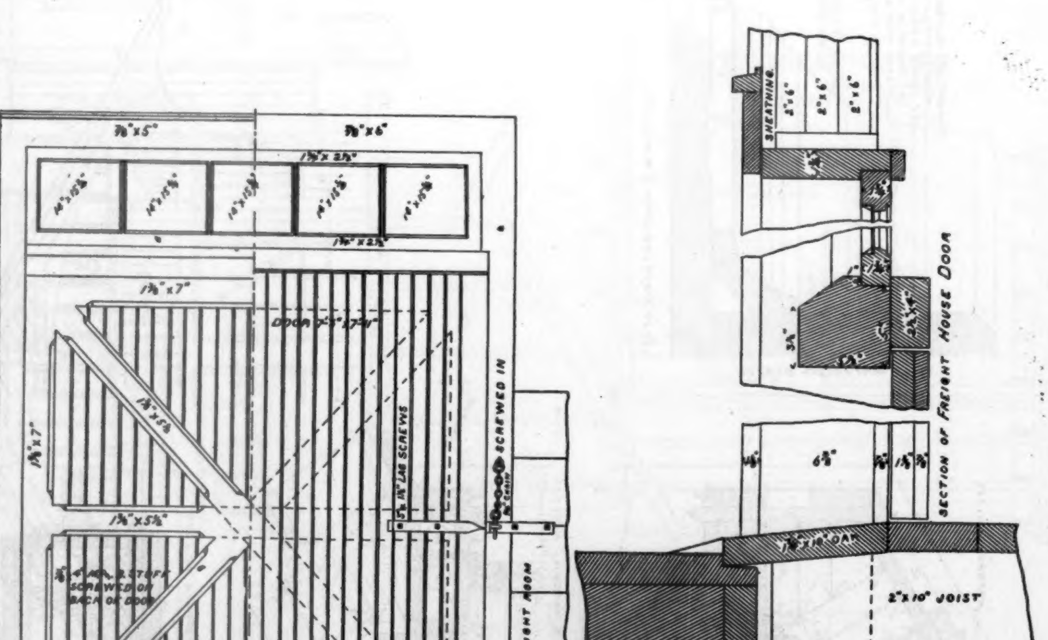

UNION PACIFIC RAILWAY
STANDARD DEPOT 24'x60'
CLASS "A".
PLATE No. 28.
RIDGE CAP
CHAMFER OF GABLE TIMBER
PITCH OF ROOF
BATTENS
BOARDS
ELEVATION OF MAIN GABLE
SECTION OF GABLE
RAFTERS
M. & B. STUFF
CONSTRUCTION OF PARTITIONS.
CENTER LINE
CEILING JOIST
SUPPORT OVER OFFICE
DETAILS OF CHIMNEY


UNION PACIFIC RAILWAY
STANDARD DEPOT 24' x 60' CLASS 'A'.
PLATE No. 30.
DETAILS OF WAINSCOTING BEARING 'J.'
DETAILS OF WINDOWS
SHEATHING
SECTION 'J.'
DETAIL AT 'N'
STILE OF DOORS
PANEL
OUTSIDE
INSIDE
CASING
DROP SIDING


UNION PACIFIC RAILWAY
STANDARD DEPOT 24' x 60' CLASS 'A'.
PLATE No. 31
ELEVATION OF BAY
SECTION THROUGH 'A B'
SECTION THROUGH 'C D'
SECTION THROUGH 'E F'
BRACKET
DETAIL OF CORNICE AT 'M'.
MATCHED & BEADED



UNION PACIFIC RAILWAY STANDARD DEPOT 24'x60' CLASS "A" PLATE No. 33.



FREIGHT ROOM DOOR

UNION PACIFIC RAILWAY STANDARD DEPOT 24'x60 CLASS "A" PLATE No. 32.

usually the telegraph table and the telegraph operator. This office should be upon the side of the station facing the main track, and the usual way is to have the telegraph table located in a bay window projecting well from the side of the station, with glass all around, so that the operator, sitting at his table, has a view a certain distance up and down the main track, or anyway can take in the greater part of the yard and side tracks. The advantages of this are obvious. Arrangements should also be made so that the operator, without moving from his table, can manipulate all the signals necessary for stopping and starting trains at that station.

Running along the front of the station, between the building and the main track, there should be a broad platform, as shown in the drawings, for the accommodation of passengers and the movement of baggage, as the baggage, for trains going in one direction at least, will usually have to be moved the whole length of the platform.

The waiting-room is for the accommodation of passengers waiting for the train. If there is only one waiting-room, it should be devoted entirely to women, and the rules of the station should prohibit any smoking, loud talking, or anything that in any way could be a nuisance to the women in it. A much better way, and one that can be followed with very little extra expense, is to have two waiting-rooms—one for women and the other for men. The size of these two waiting-rooms must depend entirely upon the local importance of the station. They should be made as comfortable as an economical expenditure of money will permit.

Opening out of the women's waiting-room there should always be a women's toilet; both waiting-rooms should be supplied, particularly in hot weather, with a liberal supply of good ice-water.

Where the freight and baggage are in one building, there are the following disadvantages: One side of the station must be clear of tracks, or, at least, available for the passage of teams and freight wagons that come to the station to receive or deliver freight. It is also a great advantage to have the side-tracks upon which the freight is loaded or unloaded as near the freight-house as possible; when this freight-house is under the same roof as the passenger station, if the side track runs next to the freight-house, all the passengers must pass to and fro over this side-track in order to reach the main track. This, although not a great source of danger, is usually a great nuisance, particularly in wet weather. On the other hand, if the main track is put next to the platform, in order that the passengers can step directly from the platform upon the train, all the freight from the side track must be moved over the passenger track to get it into the freight-house. This arrangements presents greater disadvantages than the other, for the reason that moving the freight across the main track involves much additional labor, whereas requiring passengers to walk across the side track is merely a slight inconvenience.

All this can be obviated by making the freight-house a separate building, putting it at a sufficient distance of the passenger station and locating it in such a way that the siding can be run in next to it, where it will not only afford accommodations for freight, and where the cars can be so placed that they can be loaded and unloaded directly into and out of the freight-house, but where it will also be entirely out of the way of the passenger traffic.

Plates 26, 27, 28, 29, 30, 31, 32 and 33 give elevations, plans and full details of the standard small station of the Union Pacific Company, which is about the same size as the standard station of the Atchison, Topeka & Sante Fé Railroad, described in Chapter X. The plan and the method of construction adopted in this building will be very readily seen from the drawings.

No bills of material are given with these plans for the same reason as was stated in the preceding chapter—that is, that the dimensions of every piece of timber required are noted on the plans, and also that all the details are given on a larger scale, so that for any particular case it would require very little work for the engineer to make out a proper bill of material.

Moreover, a bill of material which would answer for one particular place would, perhaps for local reasons—such as the kind of timber most easily obtained, cheapest, etc.—not be the best or most economical for another place.

In the two stations of which plans have been given no arrangement is made for living rooms for the agent and his family. When for any reason it is preferred that the agent should live in the station, a somewhat different class of building is required, and a house of this kind will be described and illustrated in a following chapter.

(TO BE CONTINUED.)

MINERAL PRODUCTS OF THE UNITED STATES.

THE sixth report on the Mineral Resources of the United States, by David T. Day, Chief of the Division of Mining Statistics and Technology, United States Geological Survey, is to be issued shortly. This report is for the calendar year 1888, and contains detailed statistics for this period, and also for preceding years, together with much descriptive and technical matter.

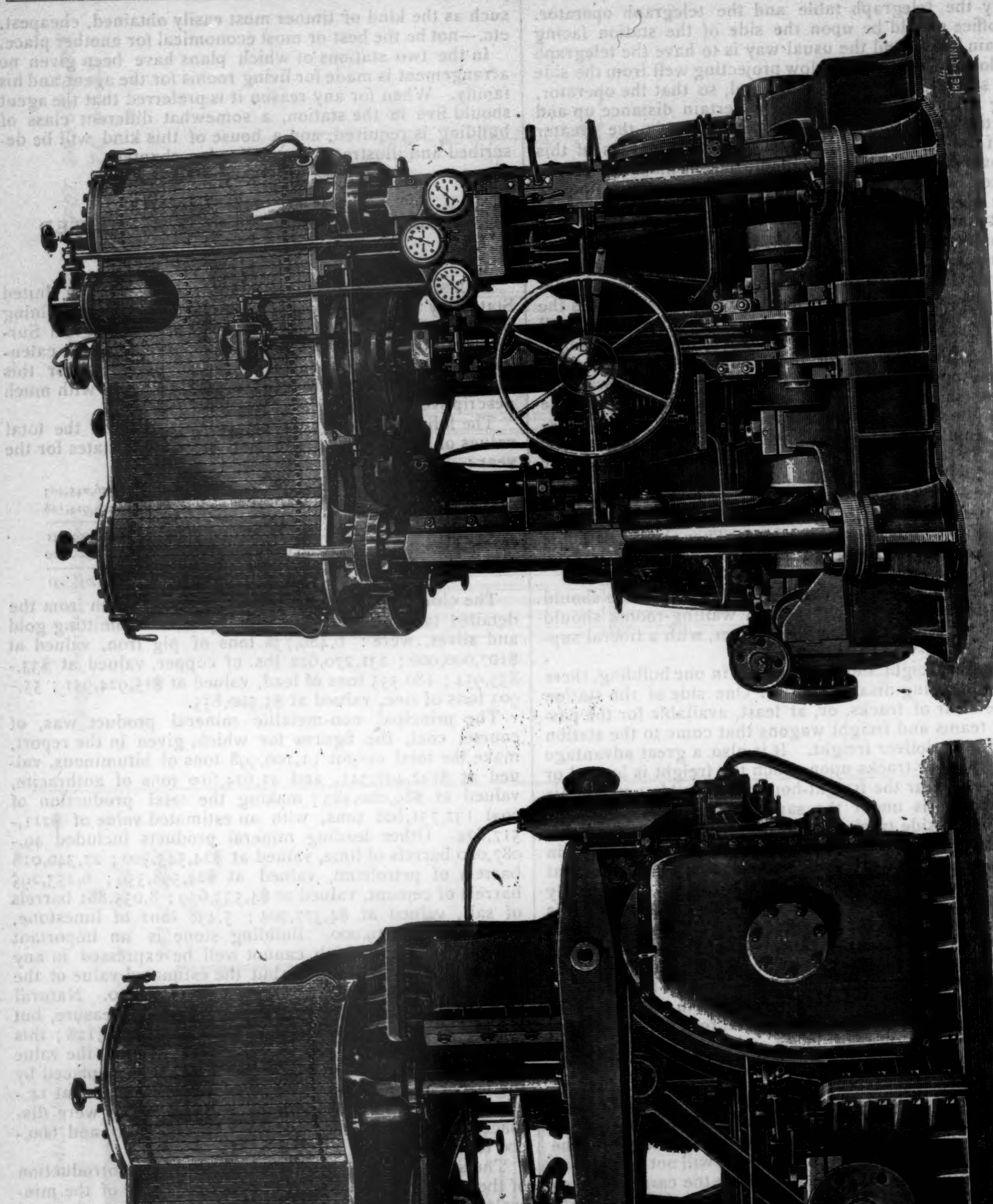
The following table gives in condensed form the total values of the mineral products of the United States for the year:

Metals	$256,245,403
Mineral substances other than metals	328,914,528
Total	$585,159,931
Estimated value of mineral products unspecified	6,500,000
Grand total	$591,659,931

The chief items of the metallic product, taken from the detailed table published in the report, and omitting gold and silver, were: 6,489,738 tons of pig iron, valued at $107,000,000; 231,270,622 lbs. of copper, valued at $33,833,954; 180,555 tons of lead, valued at $15,924,951; 55,903 tons of zinc, valued at $5,500,855.

The principal non-metallic mineral product was, of course, coal, the figures for which, given in the report, make the total output 91,106,998 tons of bituminous, valued at $122,497,341, and 41,624,610 tons of anthracite, valued at $89,020,483; making the total production of coal 132,731,608 tons, with an estimated value of $211,517,824. Other leading mineral products included 49,087,000 barrels of lime, valued at $24,543,500; 27,346,018 barrels of petroleum, valued at $24,598,559; 6,253,295 barrels of cement, valued at $4,533,639; 8,055,881 barrels of salt, valued at $4,377,204; 5,438 tons of limestone, valued at $2,719,000. Building stone is an important mineral product, which cannot well be expressed in any definite quantity or weight, but the estimated value of the stone taken out at the quarry was $25,500,000. Natural gas also cannot be expressed in weight or measure, but the money value of the yield is given at $22,662,128; this estimate is given in coal displacement—that is, the value given is that of the amount of coal which was displaced by the use of natural gas, which is given in the report at 14,163,830 tons. Of this amount 12,543,830 tons were displaced in Pennsylvania, 750,000 tons in Ohio, and 660,000 tons in Indiana.

The summary of the statement given in the introduction of the report is as follows: "The total value of the minerals produced in 1888 was $591,659,931. It is recognized that this is the sum of the values of substances taken in various stages of manufacture, and hence not strictly comparable with each other; still it is the most valuable means for comparing the total products of different years. The result is an increase of nearly $50,000,000 beyond the value of the product in 1887. In that year nearly every mineral industry showed an increase, and hence an increased total was evident. But the fact that the increase was so very large was due to rather exceptional conditions in a few important industries, and it could not reasonably be expected that a similar combination of circumstances would result in even a larger total value for 1888. Nevertheless the unprecedented stimulus given to the production of copper by an artificial price increased the total value of that product nearly $13,000,000, or nearly enough to offset the decline in the total value of pig iron. The other important factors in the increase were coal and the other fuels which followed the increased quantity of metals,



QUADRUPLE-EXPANSION ENGINES, STEAMER "SINGAPORE."

With the anticipated decline of copper to the normal demand, a decline in the total value of the product in 1889 will not be inconsistent with the natural development of our mineral resources."

The value of this series of reports on the mineral resources of the United States, as prepared under the direction of Mr. Day, has increased from year to year with the experience gained by the compilers, and the promptness with which the summary is issued this year adds to its importance and to the benefits which may be derived from it by those interested.

QUADRUPLE-EXPANSION ENGINES, STEAMSHIP "SINGAPORE."

(From the London *Engineer*.)

THE quadruple-expansion engines which have been fitted on board the steamship *Singapore*, and which are shown in the illustrations herewith, are constructed on a new design, which has been patented by the builders, Messrs. Fleming & Ferguson, of Paisley, Scotland. A prominent feature is that two piston-rods lay hold of one triangular connecting-rod, and it will be seen that in consequence there is virtually no dead point. A considerable number of these engines has recently been made by this firm, but those which have been placed in the *Singapore* are the largest quadruples which have yet been turned out, indicating as they do upward of 1,600 H.P. Economy of space and of coal consumption on board our merchant steamers has become the greatest question to be solved, and the solution of the coal consumption part of the question is being solved by the adoption of higher ranges of steam pressure carried to a greater degree of expansion, and the consequent abandonment of compound in favor of triple and quadruple-expansion engines. The advantage gained, however, by this means has been discounted to a certain extent by the fact that such engines have taken up more space on board ship than the compound engines which they displaced, and Messrs. Fleming & Ferguson, in designing the engines, set before them the necessity of economizing space, at the same time that they improved upon the latest practice in triple and quadruple-expansion work. Triple engines, when put upon three cranks, take up considerable fore-and-aft space, and have many working parts, while the quadruple engine, as ordinarily made on the tandem system, has objections which it is not necessary here to enlarge upon, but which weigh very seriously against its general adoption. In common practice it has hitherto been found that the triple is a better and for many reasons more desirable engine than an ordinary quadruple, so that the patentees of the engines have only to establish a superiority in their engine over the best type of triple-expansion engine. They have overcome most, if not all the objections to the quadruple engine, and are at least equal to the three-crank triple in the matter of balance and simplicity of overhaul, while they have to their credit an increased economy of fuel, less ship space, fewer vital working parts to keep up and look after, and a decreased friction on these parts.

As will be seen from the illustrations, the four cylinders are all on the same level, two of them being placed on the port side of the crank shaft and two on the starboard side, all standing vertically, and supported by two cast-iron columns on the condenser and two turned malleable iron columns in front, the four cylinders in this arrangement forming a very compact group. Between the cylinders are two round valve casings, in which piston valves work, there being one valve for Nos. 1 and 2 cylinders, and one valve for Nos. 3 and 4. The covers of the cylinders and valve casings are all independent, and immediately accessible for opening out for examination or overhaul. There is nothing to move before getting at any of the covers, and examination or overhaul can be made in the shortest time. The valve motion is very simple, two eccentrics only being required for either ahead or astern gear for all four cylinders. There are two links—one for each cylinder—one of which is connected directly to the eccentrics by the usual rods, and the other is actuated by the same eccentrics through a pair of bell-crank levers. There are two cranks on the crank-shaft, and these are directly opposite to each other, making the balance of working parts, at least, equal to that of a three-crank engine, while the action of this engine in its working parts is equal to four cylinders placed in line on four cranks at right angles to each other. At the same time the engine is perfectly under control, there being no position of the cranks from which they will not readily start. In the event of an accident to either of the forward pair of cylinders or to the forward crank, which would necessitate the disconnection of that engine, the after engine can be driven as a compound engine, the action of the after pistons on the crank being exactly equal to that of a compound engine with the cranks at right angles, thus obviating the difficulty of starting a single-crank engine. Another advantage of the design is that the weights may be kept very low; and still another that, owing to the breadth of the base which it has, it is perfectly steady when working at a high speed.

At the trial trip of the *Singapore* on the Clyde, the engines gave very great satisfaction to their builders, their owners, and a large party of superintending and other engineers. The steamship *Singapore* has been built by Messrs. Fleming & Ferguson for trading from Singapore to the islands adjacent, and carries 1,500 tons on a draft of 13 ft. She is a long, broad, and shallow vessel, but still a fine model, and pleasing to the eye. She is fitted with accommodation for a limited number of passengers, and has a handsome saloon and comfortable state-rooms. The entire ship is lighted by electricity. She is an exceptionally high-class cargo steamer. The speed over the measured mile in Wemys Bay averaged 12¾ knots, a result considered to be satisfactory by her owners and builders. The engines ran at about 80 revolutions for some hours without a hitch, indicating a little over 1,600 H.P. The cylinders are 24 in., 30 in., 40 in. and 60 in., respectively, in diameter. The stroke of the cylinders is 42 in., while, owing to the angle of the connecting-rod, the stroke of the cranks is 36 in. The connecting-rod is a steel casting of a triangular pattern, each angle of the base taking a piston-rod, while the apex attaches to the crank; the casting is carried beside this by a bar from the center of the base to the side of the back column. The crank and crank-shaft bearings are made very long, and though the engines were quite new, there was nothing of the nature of a hot bearing experienced during the day. The base of the engines is under 10 ft. square, and the total length of the engine-room is about 14 ft. Steam is supplied by a double-ended boiler 14 ft. 6 in. diameter and 18 ft. long, having six furnaces, and working at a pressure of 165 lbs.

The consumption of coal was very low during the trial, but will, of course, be reduced still lower when the vessel has been put into her regular trade. Messrs. Fleming & Ferguson have received a report from another of their ships fitted with similar engines, and which had lately arrived at Buenos Ayres, which report showed the consumption on the outward voyage to have been 112 lbs. per 100 indicated H.P. per hour, a remarkably high result. That this engine is growing in favor cannot be doubted, when it is stated that in the workshops of Messrs. Fleming & Ferguson there are no less than 10 sets in course of construction. The builders claim that these engines may be made suitable for paddle or screw steamers, or for pumping or factory purposes, and in any size for electric lighting. The engines illustrated are the sixth set turned out by the firm, and in every case they appear to have given satisfaction.

THE SPEED OF RAILROAD TRAINS.

IN a paper recently read by M. Banderali before the French Association for the Advancement of Science, on the speed of railroad trains in Europe, the writer gives incidentally the entire length of railroad in Europe at 129,200 miles, of which Germany has 24,600; France, 21,300; Great Britain and Ireland, 19,900; Russia, 17,700, and Austria-Hungary, 15,400 miles, no other country having over 10,000 miles.

The writer says that there are properly three classes of

railroad speed, which are expressed in the distance run per hour; these are as follows:

1. The *Commercial Speed*, which is obtained by dividing the total distance passed over between two points by the number of hours employed in the transit, without deducting the time taken by stoppages of different kinds. This speed is that which is really the most interesting to the public, and it is this speed which the tendency is to increase continually, chiefly by reducing as much as possible the number of stoppages. This commercial speed varies considerably in different countries according to the circumstances, which include the nature of the traffic, the management, and, in some degree, the national habits. In England, for instance, fast time is considered more than economy, while in Germany the circumstances are exactly reversed.

2. The *Average Running Speed* has a character much narrower and more technical than commercial speed; this is obtained by dividing the distance between the terminal stations by the actual running time, deducting the time employed in stops. This speed is regulated by a number of circumstances, such as the profile of the line, the weight of trains, the class of locomotives used, the number of junctions, crossings, and other points at which it is necessary to reduce speed, and similar matters.

3. The *Actual Speed* really varies from one minute to another, and can only be accurately measured by some sort of speed-recording machine. This speed is seldom carefully ascertained, and is, indeed, of interest chiefly to the engineer and the master mechanic, who desire to obtain exactly the power developed by the engine, the excellence of the track, the efficiency of the brakes, the good condition of the signals, and many other matters connected with the management.

The table given below compares the commercial and the average running speed (in miles per hour) of several trains on English and French roads and with one German express, to which is added the speed attained by several trains in America. It should be noted that this table does not include the exceptionally high rates of speed attained between London and Edinburgh in the recent contest between the two lines connecting those cities, which has been omitted for the reason that that fast service cannot properly be considered as an average or commercially successful performance, however interesting it may be as a specimen of what can be done upon occasion.

	Distance.	Commercial Speed.	Average Running Speed.
ENGLAND:			
London, Chatham & Dover	77.9	44.5	46.1
London, Brighton & S. Coast	50.3	46.4	47.8
London & Northwestern	159.1	45.4	47.4
Great Northern	188.3	50.1	51.3
FRANCE:			
Northern	183.9	42.9	43.8
Paris-Orleans	363.5	42.3	43.8
Eastern	275.3	40.0	41.8
Paris, Lyons & Mediterranean	536.3	35.1	56.1
GERMANY:			
Berlin-Cologne	365.4	37.6	40.6
UNITED STATES:			
New York-Pittsburgh	444.0	38.6	40.6
New York-Washington	229.2	38.2	40.5
New York-Buffalo	439.0	40.8	41.8
New York-Springfield	136.0	36.3	38.9

The longest runs made without stops in France are on the Northern Railroad, 103.2 miles in 2 hours, 17 minutes, an average of 45.3 miles an hour; on the Paris, Lyons & Mediterranean Road, 99.4 miles in 2 hours, 38 minutes, an average of 37.3 miles an hour; on the Orleans Line, 73.8 miles, at an average speed of 44.7 miles per hour; in England the longest run made without stopping is 105.4 miles in 1 hour, 57 minutes, an average of 53.9 miles an hour; in Germany the longest run without stops is 83.3 miles in 1 hour, 44 minutes, an average of 47.8 miles an hour; in Austria the Oriental Express has one run without stop between Buda-Pesth and Szgedin, 118 miles, on an average speed of 37 miles an hour.

To make these long runs without stops, it is necessary to have tenders of large capacity or else to supply the road with track-tanks, from which the water may be taken up while running. The future increase in speed—at least in the commercial speed, which is the most important—must be made rather by omitting stops than by an increase in the actual running time, and this can only be done as increased traffic demands, since the omission of stops implies additional train-service to accommodate the intermediate points between the leading stations where the fast trains stop.

The conclusion drawn is that England is at present clearly ahead in the speed of its trains, a fact which is largely due to the conditions and demands of traffic there; in Germany and Austria there are only two or three really fast trains, and in France and the United States high speed is confined to a few exceptional trains, a circumstance due to the fact that there does not exist at present a sufficient demand to warrant the expense incurred in running fast trains, since it has been abundantly proved, in both these countries, that the highest grade of speed can be obtained should it be required.

TRANSITION CURVES.

By CHARLES DAVIS JAMESON, C.E.

(*Concluded from page 272.*)

THE methods of laying out the Transition Curve may be briefly described as follows:

If the curves are put in on the preliminary location of the line, the process will be very simple. First we will consider the case in which the location is made in the field, without the previous use of a paper location. Two methods may be pursued in this case:

1. When the tangent has been located to a point at which it is desired to introduce a curve, drive a plug with a tack point and set the transit over it. Decide which one of the 12 possible parabolas shall be used, being governed in the decision by the radius of the circular curve which is to succeed the transition curve, and also by the configuration of the ground. Having selected the curve most suitable, locate points every 50 ft. by the deflections given in Table I. Having proceeded as far as it is desired on the arc of the cubic parabola, refer to the table bearing the number, in Table I., of the particular parabola selected. Following down the third column until we find the length of transition curve nearest that given, we have in the first column the degree of circular curve which can be introduced at that point; or the transition curve may be continued until the length opposite any required degree of curvature is reached. In either case the total deflection angle, given opposite that degree of curvature, is turned off and a plug with a tack point is set. Leaving the vernier in that position, the transit is taken up and set over a new point. Reverse the telescope and sight on the point just left. The zeros on the horizontal plate will then be parallel to the original tangent. Clamp the bottom plate, set the verniers to the angle in column 7, and the telescope will then be on a tangent, with the curve at that point. The circular arc can then be run in in the usual manner. To pass from the curve to the tangent is done in a similar manner, except that the intermediate points on the transition curves are located with the transit at the point of tangency. When the circular curve has been extended sufficiently, set the vernier to the angle given in column 7, turn the telescope until it is tangent to the curve, clamp it, loosen the upper plate, and set the vernier to the total deflection angle given in column 6. The telescope will now be directed to the point of tangency, or the junction of the transition curve and tangent. Measure the length

of the transition curve from the tangent. To locate this point of tangency, set up the instrument at this point, direct the telescope to the point just left, clamp, loosen the upper plate, set the vernier to zero. The telescope will

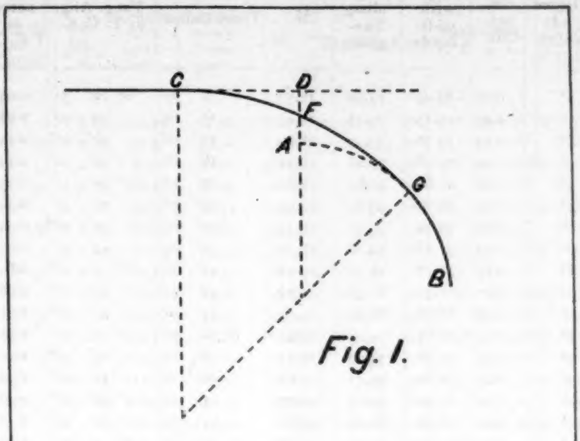


Fig. 1.

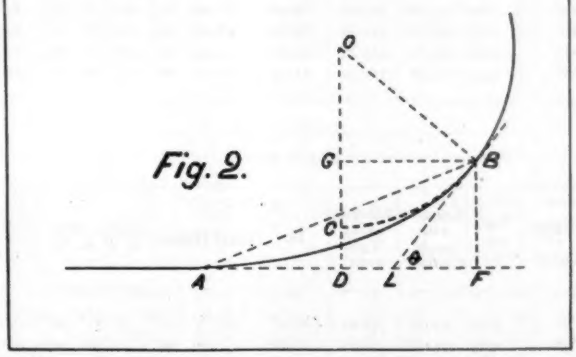


Fig. 2.

now be on the tangent. The intermediate points of the transition curve can now be located, or, if it is desirable, these can be omitted until the final location.

Another method which may be more commonly employed is as follows: When it is desired to introduce a

offset given in the tables nearest the one desired. Set the transit up on the new point, and turn it parallel to the original tangent by sighting back to some point at an equal distance from the original tangent.

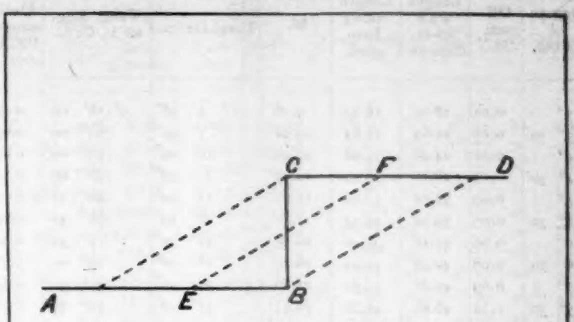


Fig. 5.

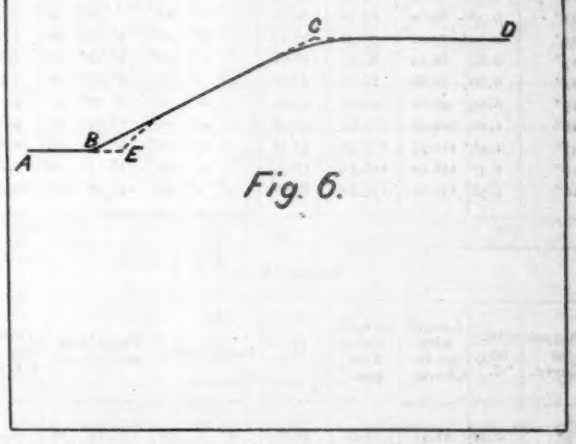


Fig. 6.

The circular curve can now be run in as usual, and the passing from the curve to the next tangent is effected in a similar manner, the offset at the end of the curve being taken of any length that will best suit the contour of the ground, no reference being had to the offset used at the

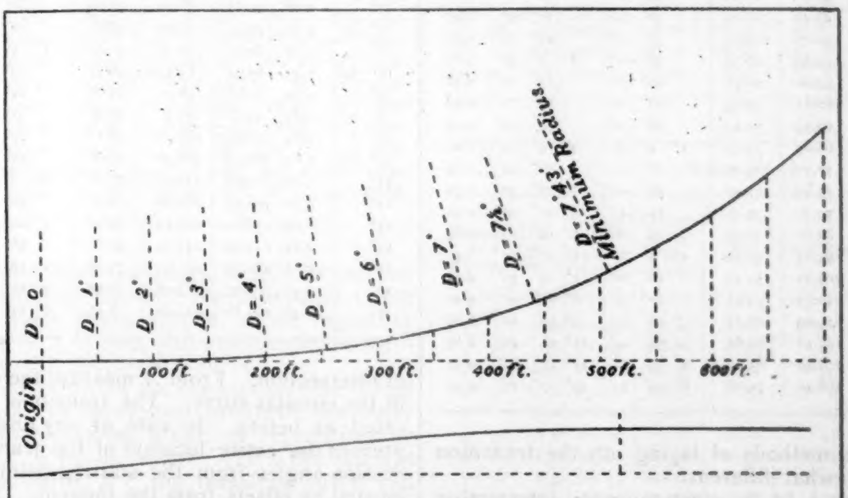


Fig. 7.

curve, run the tangent to the point *D*, fig. 2. Decide upon the offset and also the degree of circular curve which it is desired to use. Both of these may be varied so as to fit the ground. With the given degree of curve refer to the tables. The desired offset will be found if it is within the limits of the cubic parabolas tabulated. Measure off the

beginning of the curve. The transition curves can then be located at any time by measuring back on the tangent, from the point *D*, the distance given in column *M*. Set up the transit at this point, and deflect the angles given in Table I. for that parabola.

When the tangents are already fixed and the central

CURVE No. 1.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0.01	18 72	18.72	9.36	0° 5′ 20″	0° 16′ 00″	0 03
3° 30′	0.01	21.85	21.85	10.92	7′ 40″	23′ 00″	0.05
4°	0.02	24.98	24.98	12.49	10′ 00″	30′ 00″	0 07
4° 30′	0.02	28.10	28.10	14.05	12′ 40″	38′ 00″	0.10
5°	0.03	31.22	31.22	15.61	15′ 40″	46′ 50″	0.14
5° 30′	0.05	34.34	34.34	17.17	18′ 50″	56′ 40″	0.19
6°	0 06	37.46	37.46	18.73	22′ 30″	1° 7′ 30″	0.24
6° 30′	0.08	40.59	40.59	20.29	26′ 20″	19′ 10″	0.31
7°	0.09	43.72	43.72	21.86	30′ 40″	31′ 50″	0.37
7° 30′	0.12	46.86	46.86	23.43	35′ 10″	45′ 30″	0.48
8°	0.14	50.00	50.00	24.95	40′ 00″	2° 00′ 10″	0.58
8° 30′	0.17	53.14	53.14	26.50	45′ 10″	15′ 40″	0.70
9°	0.20	56.29	56.29	28.07	50′ 50″	32′ 10″	0.83
9° 30′	0.24	59.47	59.46	29.65	56′ 40″	49′ 50″	0.98
10°	0.28	62.64	62.62	31.21	1° 2′ 50″	3° 8′ 10″	1.14
10° 30′	0.33	65.82	65.80	32.75	9′ 20″	27′ 50″	1.33
11°	0.38	69.04	69.01	34.30	16′ 20″	48′ 30″	1.53
12°	0.50	75.50	75.46	37.43	31′ 20″	4° 33′ 20″	2.00
13°	0.64	82.12	82.05	40.60	47′ 50″	5° 22′ 30″	2.57
14°	0.80	88.86	88.77	43.78	2° 6′ 10″	6° 17′ 10″	3.26
15°	0.99	95.89	95.67	47.05	26′ 30″	7° 17′ 30″	4.08
16°	1.20	102.98	102.82	50.36	49′ 10″	8° 24′ 20″	5.06
17°	1.46	110.53	110.36	53 58	3° 14′ 50″	9° 39′ 40″	6.26
18°	1.77	118.82	118.42	56.93	44′ 20″	11° 5′ 30″	7.74
20°	2.56	138.26	137.40	63.91	5° 1′ 40″	14° 47′ 00″	12.09

CURVE No. 2.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0.01	21.41	21.41	10.70	0° 6′ 30″	0° 19′ 20″	0.04
3° 30′	0.01	24.98	24.98	12.49	8′ 40″	26′ 10″	0.06
4°	0.02	28.56	28 56	14.28	11′ 30″	34′ 20″	0.09
4° 30′	0.03	32.13	32.13	16.07	14′ 30″	43′ 20″	0.13
5°	0.05	35.70	35.70	17.85	17′ 50″	53′ 40″	0.19
5° 30′	0.06	39.28	39.28	19.64	21′ 40″	1° 4′ 50″	0.25
6°	0.08	42.86	42.86	21.43	25′ 40″	17′ 10″	0.32
6° 30′	0.10	46.44	46.44	23.22	30′ 10″	30′ 40″	0.41
7°	0.12	50.01	50.01	25.00	35′ 00″	45′ 00″	0.51
7° 30′	0.15	53.60	53.60	26.78	40′ 10″	2° 0′ 40″	0.63
8°	0.19	57.21	57.20	28.56	45′ 50″	17′ 30″	0.76
8° 30′	0.23	60 82	60.81	30.34	51′ 50″	35′ 20″	0.92
9°	0.27	64.44	64.43	32.13	58′ 10″	54′ 20″	1.09
9° 30′	0.32	68.09	68.07	33.93	1° 4′ 50″	3° 14′ 30″	1.29
10°	0.37	71.75	71.73	35.72	12′ 00″	36′ 00″	1.50
10° 30′	0.43	75.43	75.40	37.50	19′ 40″	58′ 30″	1.75
11°	0.50	79.15	79.10	39.32	27′ 40″	4° 22′ 30″	2.02
12°	0.64	86.66	86.60	42.94	45′ 00″	5° 14′ 20″	2.65
13°	0.83	94.34	94.25	46.57	2° 4′ 20″	6° 11′ 50″	3.41
14°	1.02	102.25	102.11	50 22	26′ 00″	7° 15′ 50″	4.34
15°	1.30	110.57	110.35	53.95	50′ 30″	8° 28′ 00″	5.47
16°	1.60	119.41	119.09	57.75	3° 18′ 30″	9° 50′ 10″	6.88
17°	1.98	129.31	128.51	61.64	51′ 00″	11° 24′ 40″	8.65
18°	2.38	139 70	138.97	65.61	4° 30′ 00″	13° 17′ 00″	10.93
20°	3 57	170.14	168.40	74.08	6° 35′ 30″	19° 7′ 10″	19 45

angles known, the methods of laying out the transition curves will be somewhat different.

Let *A B, B C*, fig. 4, be the given tangents, intersecting at *B* with an external angle Δ. Let $A D = d$, the offset at A; $F C = d'$, the offset at C. Let R = radius of the circular curve. These may be selected to suit the ground. The tangent distance

$$A B = D B' + E B = R \text{ tang. } \tfrac{1}{2}\Delta + d \cot. \Delta + d' \operatorname{cosec} \Delta,$$

and tangent distance

$$B C = R \text{ tang. } \tfrac{1}{2}\Delta + d' \cot. \Delta + d \operatorname{cosec} \Delta.$$

Measure off the tangent distance *A B* from the point

CURVE No. 3.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinates at P.C.C.
3°	0.01	24.99	24.99	12.50	0° 7′ 30″	0° 22′ 30″	0.05
3° 30′	0.02	29.15	29.15	14.57	10′ 10″	30′ 40″	0.08
4°	0.03	33.32	33.32	16.66	13′ 20″	40′ 00″	0.13
4° 30′	0.04	37.48	37.48	18.74	16′ 50″	50′ 30″	0.19
5°	0.06	41.64	41.64	20.82	20′ 50″	1° 02′ 30″	0.25
5° 30′	0.08	45.82	45.82	22.91	25′ 10″	15′ 40″	0.33
6°	0.11	49 99	49.99	24.99	30′ 00″	30′ 00″	0.44
6° 30′	0.14	54.18	54.18	27.08	35′ 20″	45′ 40″	0.55
7°	0.17	58.38	58.38	29.16	41′ 00″	2° 2′ 40″	0.69
7° 30′	0.21	62.58	62.58	31.24	47′ 00″	21′ 00″	0.86
8°	0.26	66.81	66 80	33.33	53′ 30″	40′ 30″	1.04
8° 30′	0.31	71.04	71.03	35.41	1° 00′ 30″	3° 1′ 30″	1.25
9°	0.37	75 31	75.29	37.51	8′ 00″	23′ 50″	1.49
9° 30′	0.44	79.60	79.57	39.61	16′ 00″	47′ 40″	1.76
10°	0 51	83.92	83.87	41.70	24′ 30″	4° 12′ 50″	2.06
10° 30′	0.60	88.26	88.20	43.81	33′ 20″	39′ 30″	2.40
11°	0.69	92.66	92.58	45.92	42′ 50″	5° 7′ 50″	2 77
12°	0.90	101.64	101.54	50.19	2° 03′ 50″	6° 10′ 00″	3 66
13°	1.15	110.94	110.78	54.47	27′ 20″	7° 19′ 30″	4 75
14°	1.42	120.68	120.42	58 82	54′ 00″	8° 38′ 20″	6.10
15°	1.79	131.98	130.59	63.22	3° 24′ 30″	10° 7′ 50″	7 78
16°	2.23	142.19	141.60	67.68	4° 00′ 20″	11° 51′ 50″	9.91
17°	2.77	155.26	154.36	72.37	45′ 30″	14° 1′ 00″	12.84
18°	3.45	171.82	170.30	77.29	5° 47′ 00″	16° 54′ 00″	17.25

CURVE No. 4.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0 02	29.99	29.99	14.99	0° 9′ 00″	0° 27′ 00″	0.08
3° 30′	0.03	34.99	34.99	17.49	12′ 20″	36′ 40″	0.12
4°	0.05	39.99	39 99	19 99	16′ 00″	48′ 00″	0.19
4° 30′	0.06	44 99	44.99	22.49	20′ 20″	1° 00′ 50″	0.26
5°	0.09	50.00	50.00	24.99	25′ 00″	15′ 00″	0.36
5° 30′	0.12	55 02	55.02	27.50	30′ 20″	30′ 50″	0.48
6°	0.16	60.04	60.04	30 00	36′ 00″	48′ 10″	0.63
6° 30′	0 20	65.09	65.08	32.50	42′ 20″	2° 7′ 00″	0.80
7°	0.26	70.13	70.12	35.00	49′ 10″	27′ 30″	1 00
7° 30′	0.31	75.22	75.20	37.51	56′ 30″	49′ 30″	1.24
8°	0.37	80 31	80.29	40.02	1° 4′ 30″	3° 13′ 20″	1.51
8° 30′	0.45	85.44	85.41	42.53	13′ 00″	38′ 40″	1.81
9°	0.54	90.60	90 57	45.05	22′ 00″	4° 5′ 40″	2 16
9° 30′	0.63	95.81	95.77	47.57	31′ 40″	34′ 40″	2.56
10°	0.74	101.08	101.03	50.12	42′ 00″	5° 5′ 30″	3.00
10° 30′	0.85	106.44	106.36	52.66	53′ 10″	38′ 20″	3.50
11°	0.99	111.88	111.76	55.22	2° 5′ 00″	6° 13′ 20″	4.06
12°	1.30	123.05	122.86	60.36	30′ 50″	7° 30′ 20″	5.40
13°	1.67	134.80	134.49	65 58	3° 00′ 40″	8° 58′ 20″	7.08
14°	2.14	147.52	147 03	70.89	36′ 00″	10° 41′ 10″	9.25
15°	2.70	161.73	160.95	76.36	4° 18′ 40″	12° 44′ 30″	12.13
16°	3.41	178.27	177.96	82.18	5° 16′ 00″	15° 27′ 10″	16.40
17°	4.38	206.16	203.60	88.46	6° 52′ 40″	19° 53′ 30″	24.56

of intersection. From *A* measure the offset *A D*, and run in the circular curve. The transition curves are then located as before. In case of any obstacle which would prevent the entire location of the transition curve by deflection angles from the starting-point, the curve may be located by offsets from the tangent. These are given for this purpose in the tables.

RAIL ELEVATION.

As has already been stated, the elevation of the outer rail should be proportional to the degree of curvature, or inversely proportional to the radius. When this condition is fulfilled for a certain speed, the train is in perfect equilibrium upon every part of the curve. Since with the cubic parabola the radius of curvature varies nearly in-

CURVE No. 5.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0.03	37.49	37.49	18.74	0° 11' 20"	0° 33' 50"	0.12
3° 30'	0.05	43.74	43.74	21.87	15' 20"	46' 00"	0.19
4°	0 07	50.01	50.01	25.00	20' 00"	1° 00' 00"	0.29
4° 30'	0.10	56.25	56.25	28.12	25' 20"	16' 00"	0.41
5°	0.14	62.55	62.54	31.26	31' 20"	33' 50"	0.57
5° 30'	0.19	68.84	68.83	34.37	37' 50"	53' 40"	0.76
6°	0.25	75.15	75.13	37.50	45' 10"	2° 15' 30"	0.99
6° 30'	0.31	81.47	81.45	40.63	53' 00"	39' 10"	1.26
7°	0.39	87.84	87.81	43.77	1° 1' 40"	3° 5' 00"	1.58
7° 30'	0.48	94.24	94.21	46.92	11' 00"	32' 50"	1.95
8°	0.58	100.70	100.66	50.08	21' 00"	4° 2' 50"	2.37
8° 30'	0.70	107.23	107.17	53.20	31' 50"	35' 10"	2.86
9°	0.84	113 84	113.75	56 41	43' 30"	5° 9' 50"	3.43
9° 30'	0.99	120.53	120.42	59.59	56' 00"	47' 00"	4.06
10°	1.16	127.37	127.22	62.80	2° 9' 20"	6° 26' 50"	4 79
10° 30'	1.35	134.36	134.16	66 02	24' 00"	7° 9' 50"	5.62
11°	1.56	141.52	141.26	69.26	39' 30"	56' 00"	6.56
12°	2.08	156.62	156.20	75.83	3° 15' 00"	9° 40' 00"	8.87
13°	2.71	173.37	172.65	82.58	58' 10"	11° 45' 30"	11.98
14°	3.53	193.40	192.17	89.69	4° 54' 40"	14° 27' 30"	16.52
15°	4.62	222.29	219.85	97.40	6° 25' 10"	18° 39' 00"	24.73

CURVE No. 6.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinates at P.C.C.
3°	0.06	50.00	50.00	25.00	0° 15' 00"	0° 45' 00"	0.22
3° 30'	0.09	58.35	58.35	29.17	20' 30"	1° 1' 20"	0.35
4°	0.13	66.72	66 72	33.35	26' 40"	20' 10"	0.52
4° 30'	0.18	75.08	75.08	37.51	33' 50"	41' 30"	0.74
5°	0.26	83.49	83.49	41.69	41' 50"	2° 5' 20"	1.02
5° 30'	0.34	91.91	91.90	45.86	50' 40"	32' 00"	1.35
6°	0.44	100.38	100.36	50.04	1° 00' 30"	3° 1' 10"	1.76
6° 30'	0.56	108.93	108.90	54.24	11' 10"	33' 10"	2.25
7°	0.70	117.55	117.50	58 44	22' 50"	4° 8' 00"	2.83
7° 30'	0.86	126.28	126.20	62.66	35' 30"	46' 00"	3.51
8°	1.05	135.15	135.04	66.90	49' 20"	5° 27' 20"	4.30
8° 30'	1.27	144.20	144.04	71.17	2° 4' 20"	6° 12' 00"	5.22
9°	1.52	153 43	153.22	75.45	20' 50"	7° 0' 30"	6.28
9° 30'	1.80	162.99	162.70	79.79	38' 40"	53' 30"	7.52
10°	2.12	172.87	172.47	84.14	58' 20"	8° 51' 10"	8.95
10° 30'	2.48	183.39	182.85	88.62	3° 20' 30"	9° 55' 50"	10.67
11°	2.90	194.42	193.70	93.11	44' 50"	11° 6' 50"	12.68
12°	3.92	219.78	218 46	102.41	4° 45' 40"	14° 2' 00"	18.20
13°	5.37	257.06	254.21	112.54	6° 26' 10"	18° 41' 50"	28.68

versely as the distance from the origin, it follows that the elevation of the outer rail should be proportional to the distance from the same point—that is, at the beginning of the transition curve it is zero, and would increase regularly to its junction with the circular curve.

If the degree of curvature of the transition curve varied exactly as its length, the theoretical profile of the outer rail would be a simple inclined plane, as represented by the dotted line *B C* in fig. 6, where *A B* is the straight track preceding the curve, *B C* the transition curve, and *C D* the circular curve. But, as has already been seen, with the cubic parabola the degree of curvature is not exactly proportional to the distance from the origin. The change becomes less rapid as we approach the point of minimum radius. To correspond with this the profile of the outer rail would be slightly curved near its union with the circular curve, as shown in fig. 7. Instead of joining the level portion at an angle, the profile of the outer rail would be rounded off by a vertical curve of greater or less extent. This is a peculiarity of the cubic parabola, none of the other transition curves giving such a curve to the outer rail. The railroad spiral gives, it is true, a curved

CURVE No. 7.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0.08	60.01	60.01	30.00	0° 18' 00"	0° 54' 00"	0.31
3° 30'	0.13	70.04	70.04	35.00	24' 30"	1° 13' 30"	0 50
4°	0.19	80.09	80.09	40.01	32' 00"	36' 10"	0.75
4° 30'	0.27	90.16	90.15	45.01	40' 40"	2° 1' 50"	1.07
5°	0.37	100.27	100.26	50.03	50' 10"	30' 40"	1.47
5° 30'	0.49	110.45	110.43	55.05	1° 1' 00"	3° 2' 50"	1.96
6°	0.63	120.70	120.66	60.09	12' 50"	38' 10"	2.55
6° 30'	0.81	131.10	131.03	65.14	25' 50"	4° 17' 00"	3.27
7°	1.01	141.64	141.54	70.23	40' 10"	59' 40"	4.12
7° 30'	1.25	152.32	152.18	75.31	55' 50"	5° 46' 10"	5.13
8°	1.53	163.31	163.10	80.45	2° 13' 00"	6° 37' 10"	6.31
8° 30'	1.85	174.64	174.34	85.64	31' 50"	7° 33' 20"	7.71
9°	2.22	186.40	185.99	90.87	52' 50"	8° 35' 00"	9.36
9° 30'	2.65	198.80	198.23	96.21	3° 16' 20"	9° 43' 40"	11.33
10°	3.14	212.03	211.26	101.62	42' 50"	11° 1' 10"	13 72
10° 30'	3.71	226.16	225.09	107.04	4° 12' 50"	12° 28' 00"	16 59
11°	4.48	242.54	241.03	112.77	49' 50"	14° 13' 30"	20.37
12°	6.19	291.65	287.76	125.10	6° 52' 00"	19° 51' 50"	34.65

CURVE No. 8.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0.12	75.03	75.03	37.49	0° 22' 30"	1° 7' 30"	0.49
3° 30'	0.20	87.58	87.58	43.75	30' 40"	32' 00"	0.78
4°	0.29	100.18	100.18	50.03	40' 10"	2° 00' 20"	1.17
4° 30'	0.31	112.81	112.80	56.29	50' 50"	32' 40"	1.67
5°	0.57	125.56	125.53	62.57	1° 3' 00"	3° 9' 00"	2.30
5° 30'	0.76	138.44	138.38	68.88	16' 30"	49' 30"	3.08
6°	0 99	151.45	151 36	75.20	33' 50"	4° 34' 20"	4.03
6° 30'	1.27	164.74	164 61	81.56	48' 20"	5° 24' 10"	5.19
7°	1.60	178.30	178.10	87.97	2° 6' 50"	6° 19' 10"	6 57
7° 30'	1.98	192.33	192.03	94.42	27' 30"	7° 20' 10"	8 24
8°	2.43	206.91	206 47	100 94	50' 20"	8° 27' 50"	10.24
8° 30'	2.96	222.41	221.78	107.62	3° 16' 30"	9° 44' 33"	12.69
9°	3.48	238.98	238.07	114.37	46' 20"	11° 11' 30"	15.70
9° 30'	4.31	257.38	256.08	121.33	4° 21' 50"	12° 53' 40"	19.54
10°	5.20	278 96	277.02	128.57	5° 6' 10"	14° 59' 50"	24.73
10° 30'	6.30	307.19	304.09	136.20	6° 8' 30"	17° 53' 30"	32.72

CURVE No. 9.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tangent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordinate at P.C.C.
3°	0.22	100.09	100.09	50.00	0° 30' 00"	1° 30' 10"	0.87
3° 30'	0.35	116.89	116.88	58.35	41' 00"	2° 2' 50"	1.39
4°	0.52	133.80	133.78	66.74	53' 40"	41' 00"	2.09
4° 30'	0.74	150.79	150.75	75.10	1° 8' 10"	3° 24' 20"	2.99
5°	1.02	168.07	167.99	83.54	24' 40"	4° 13' 30"	4.14
5° 30'	1.37	185.65	185.52	92.01	43' 10"	5° 9' 00"	5.57
6°	1.79	203.64	203.42	100.52	2° 4' 00"	6° 11' 00"	7.35
6° 30'	2.30	222.33	221.98	109.14	27' 40"	7° 21' 00"	9.55
7°	2 91	241.83	241.30	117.85	54' 30"	8° 40' 00"	12.26
7° 30'	3.64	262.92	262.10	126.81	3° 25' 50"	10° 11' 50"	15.71
8°	4.52	285.84	284.60	135.90	4° 2' 40"	11° 58' 20"	20.12
8° 30'	6.07	312.33	310.40	145.33	48' 20"	14° 9' 30"	26.10
9°	6.98	346.41	343.20	155.28	5° 52' 10"	17° 8' 20"	35.28

outer rail profile, but, as will be seen from *E C*, fig. 6, the curve is an objection rather than an advantage.

The method of adjusting the outer rail on a transition curve composed of cubic parabolas is very simple. After calculating in the usual manner the proper elevation to

CURVE NO. 10.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tan-gent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordi-nate at P.C.C.
3°	0.49	150.3	150.3	75.0	0° 45′ 10″	2° 15′ 30″	1.97
3° 30′	0.78	175.7	175.7	87.6	1° 3′ 10″	3° 5′ 00″	3.15
4°	1.18	201.6	201.5	100.2	21′ 10″	4° 3′ 10″	4.76
4° 30′	1.69	227.9	227.7	112.9	43′ 40″	5° 10′ 10″	6.87
5°	2.34	255 0	254.7	125.7	2° 9′ 40″	6° 27′ 30″	9.61
5° 30′	3.15	283.5	283.0	138 7	40′ 00″	7° 57′ 30″	13.19
6°	4.18	314.0	313.1	151.9	3° 15′ 50″	9° 42′ 30″	17.86
6° 30′	5.46	347.9	346.4	165.6	59′ 40″	11° 49′ 40″	24.18
7°	7.11	388.2	385.6	179.8	4° 56′ 40″	14° 32′ 50″	33.36
7° 30′	9.33	447 0	441.9	195.3	6° 29′ 00″	18° 49′ 10″	50.20

CURVE NO. 11.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tan-gent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordi-nate at P.C.C.
3°	0.88	200 7	200.7	100.1	1° 00′ 30″	3° 1′ 00″	3.53
3° 30′	1.40	235.2	235.1	116.9	22′ 50″	4° 8′ 22″	5.67
4°	2.12	270.4	270.2	133.9	52′ 00″	5° 27′ 30″	8.61
4° 30′	3.05	307.0	306.6	151.0	2° 21′ 00″	7° 00′ 50″	12.58
5°	4.25	346.1	345.3	168.4	58′ 40″	8° 52′ 20″	17 97
5° 30′	5.82	389.6	388.1	186.5	3° 45′ 40″	11° 9′ 10″	25.50
6°	7.90	441.1	438 4	205.3	4° 47′ 40″	14° 7′ 10″	36.77
6° 30′	10.81	517.2	511.2	225.7	6° 30′ 20″	18° 53′ 10″	58.29

CURVE NO. 12.

Degree of Curve.	Off-set, "d."	Length with 50-ft. Chords.	Length along Tan-gent.	M.	Total Deflec.	Tang. Ang. at P. C. C.	Ordi-nate at P.C.C.
3°	2.02	303.0	302.8	150 4	1° 31′ 40″	4° 34′ 30″	8.08
3° 30′	3 20	356.7	356.3	175.9	2° 6′ 50″	6° 19′ 20″	13.16
4°	4.89	414.1	413.2	202.0	50′ 40″	8° 28′ 30″	20.52
4° 30′	7.19	478.5	476.7	229.0	3° 47′ 00″	11° 13′ 00″	31.51
5°	10.43	559.0	555.0	257.5	5° 7′ 10″	15° 2′ 50″	49 73

the rails on the circular curve, mark a point on the transition curve 5, 10, 20, or more feet from its juncture with the circular curve, depending upon the length of the transition curve, beginning at the point of curve to elevate the rail, so that if continued it would obtain its full elevation at the point marked. But before that point is reached, begin to introduce the vertical curve and obtain the full elevation at the beginning of the circular curve.

Fig. 7 shows the cubic parabola, No. 10 of the table, plotted to a scale of 100 ft. to the inch. At the origin the radius of curvature is infinity, and the degree of curvature zero. From this point the degree of curvature begins to increase at the rate of one degree for every 50 ft. This rate of increase begins to decrease perceptibly after the first 200 ft., so that near the point marked minimum radius the rate is scarcely one degree in 100 ft. After passing the point of the minimum radius, the radius begins to increase until, finally, it becomes infinite at an infinite distance.

In the lower part of the figure is shown the corresponding profile of the outer rail. The horizontal scale is 100 ft. to the inch, and the vertical scale 20 ft. to the inch, in order to render the elevation more apparent.

In the table giving the deflection angles and offsets for locating the intermediate points on transition curves, the 50-ft. chords for the deflection angles are, of course, measured along the curve, while the distances for the offsets are measured along the original tangent.

The following formulas can be applied to the foregoing transition curves with approximate accuracy. As will be seen by comparing results given by them with the tables, they are correct when only a very small offset is taken, but as the offset increases, the error also increases.

They will undoubtedly be of value to the field engineer upon location, as they can be memorized, and thus avoid the necessity of carrying the tables into the field when only the circular curves are to be run with the offsets, but the transition curves not run in until the final location.

The approximate total length of the transition curve can be obtained at once, and its approximate position on the ground. In this manner they may be of some use, but for the accurate running in of the curves the tables should be used.

$$l = 1000 \frac{D}{a}$$

$$a = \sqrt{\frac{D^2}{10.1367\, d}}$$

$$\theta = 37.2 \sqrt{d\, D}$$

$$l = 370 \sqrt{\frac{d}{D}}$$

DEFLECTION ANGLES AND OFFSETS FOR LOCATING INTERMEDIATE POINTS ON TRANSITION CURVES.

	Curve No. 1.		Curve No. 2.		Curve No. 3.	
	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.
50	40′ 00″	0.58	35′ 00″	0.51	30′ 00″	0 44
100	2° 39′ 40″	4.66	2° 19′ 50″	4.07	2° 00′ 00″	3.49
150			5° 10′ 00″	13.75	4° 26′ 50″	11.79

	Curve No. 4.		Curve No. 5.		Curve No. 6.	
	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.
50	25′ 00″	0 36	20′ 00″	0.29	15′ 00″	0.22
100	1° 40′ 00″	2.91	1° 20′ 00″	2.33	1° 00′ 00″	1 75
150	3° 43′ 10″	9.81	2° 59′ 00″	7.85	2° 14′ 30″	5.89
200			5° 14′ 30″	18.62	3° 57′ 40″	13.96

	Curve No. 7.		Curve No. 8.		Curve No. 9.	
	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.
50	12′ 30″	0.18	10′ 00″	0.15	7′ 30″	0.11
100	50′ 00″	1.45	40′ 00″	1.16	30′ 00″	0.87
150	1° 52′ 20″	4.91	1° 30′ 00″	3.93	1° 7′ 30″	2.95
200	3° 18′ 40″	11.64	2° 39′ 20″	9 31	1° 59′ 40″	6.98
250	5° 7′ 10″	22.73	4° 7′ 10″	18.18	3° 5′ 00″	13.64
300					4° 26′ 40″	23.56

	Curve No. 10.		Curve No. 11.		Curve No. 12.	
	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.	Defl. Angles, 50-ft. Chords.	Off-sets.
50	5′ 00″	0.07	3′ 45″	0.05	2′ 30″	0.04
100	20′ 00″	0.58	15′ 00″	0.44	10′ 00″	0.29
150	45′ 00″	1.96	33′ 45″	1.47	22′ 30″	0.98
200	1° 19′ 50″	4.65	1° 00′ 00″	3 49	40′ 00″	2.33
250	2° 4′ 40″	9.09	1° 33′ 40″	6.82	1° 2′ 30″	4.55
300	2° 59′ 00″	15.71	2° 14′ 30″	11.78	1° 30′ 00″	7.85
350	4° 2′ 20″	24.94	3° 2′ 40″	18.71	2° 2′ 10″	12.47
400	5° 14′ 10″	37.23	3° 57′ 30″	27.93	2° 39′ 20″	18.62
450			4° 58′ 50″	39.76	3° 21′ 00″	26 51
500					4° 7′ 20″	36.36

θ = Total deflection angle in minutes.
a = Deflection at first 100 ft. in minutes.
d = Total offset in feet.
D = Degree of circular curve.
l = Total length of transition curve in feet.

From this we see that the length of the transition curve varies approximately as the square root of the offset, and for a given offset inversely as the degree of curve.

RELINING A TUNNEL IN USE.

[Note by M. G. Liebeaux, Chief Engineer of the Orleans Railroad, in the *Revue Genérale des Chemins de Fer*.]

THE Saulzaie Tunnel, on the Angers-Nantes line of the Orleans Railroad, is near the station of Clermont-sur-Loire, and is 85 meters (279 ft.) in length.

It was cut through an old formation of mica-schist, having the form of schistous masses, the strata sharply inclined toward the foot of the hill and separated by thin veins of clay, proceeding from the decomposition of the mica, and cut in different directions by cracks or fissures.

When the tunnel was built, the engineers, struck by the hardness of the rock, supposed that the mass was homogeneous, and concluded—wrongly, as the result shows—that lining was not necessary. They simply built at each end a portal or arch extending 7 meters into the tunnel.

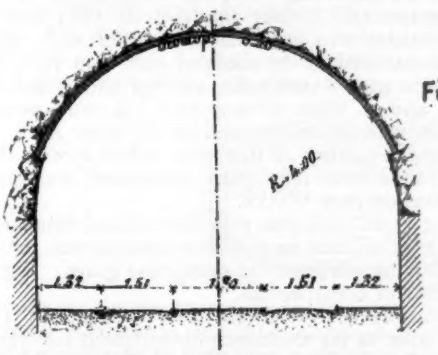


Fig. 1.

Under the influence of air and moisture disintegration began. Water also, working through the fissures, acted on the clay veins, and soon the fall of schistous masses, more or less considerable in size, was noted.

In 1866 a plan was prepared for building a complete lining 0.11 meter thick, but it was never carried out.

About 1880 new falls of rock from the roof began. A little masonry was put in and special service for watching the tunnel was arranged. A day-watchman and later a night-watchman were stationed permanently at the tunnel.

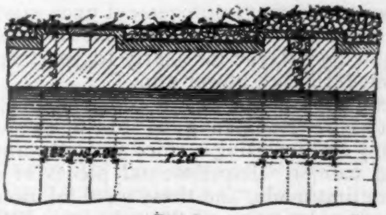


Fig. 3.

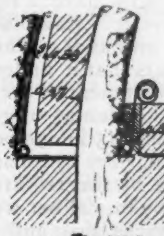


Fig. 4.

Their duty was to pass through the tunnel just before each train was due, and to give the signal to stop, in case of a fall of rock.

The cost of this was considerable, the salaries of the two watchmen amounting to 2,400 francs a year. Safety was guaranteed, but damage to the tunnel was not prevented, and the arrangement was evidently only a temporary postponement of the problem, not a proper solution.

Evidently it would be better to use all or part of the capital corresponding to the yearly cost of watching the tunnel in the execution of permanent works which would make the tunnel safe and do away with the necessity of special care.

The best solution would have been the complete lining of the tunnel with masonry; unfortunately the conditions were such and the expense so great as to raise serious objections to this.

The plan proposed in 1866 was more theoretical than practical. It proposed the construction of a circular arch 4 meters radius and 8.50 meters development. The rock was to be cut out to receive the arch.

The difficulty laid precisely in this cutting out. In a compact rock unchangeable when exposed to air, the operation would have been costly but simple, but in the Saulzaie Tunnel it was not possible, on account of the inclination of the strata and the nature of the rock itself. Several trials made for this special purpose proved that it would be entirely impossible to make recesses which would give any regular bearing surface, and a complete arch would be necessary.

The Saulzaie Tunnel has not the full standard size, being only 7.40 meters in width instead of 8.00 meters, which is the size adopted for double-track tunnels. It was thus impossible to reduce the size any further, by building supporting walls to sustain the arch, and it was necessary to use the existing supports or to cut out the rock in a way which had not been foreseen in 1866.

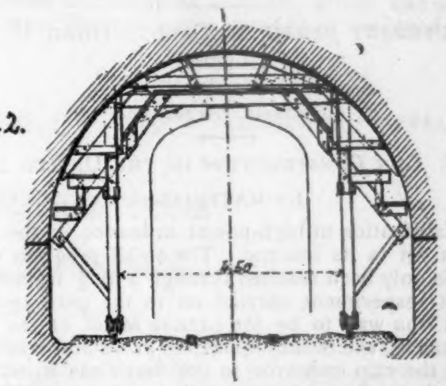


Fig. 2.

The expense and the work of a complete relining thus took on new importance. In 1866 the expense, it was thought, would not be over 11,000 francs, but later it was found that a correct estimate would be fully five times that amount.

Fortunately a careful examination of the tunnel, with soundings and borings in the rock, revealed the fact that a complete relining would not be necessary, and that there were really only two dangerous sections, one 6 meters in length at the eastern end of the tunnel, and the other 8 meters long at a point 22 meters from the western portal. In these sections there were many cracks, deep holes, and a marked crumbling of the rock.

The construction, not of an arch 0.11 meter thickness, but of two heavier rings solidly founded, seemed to be sufficient to meet and remedy the evil. This expectation has been realized. The work has been completed for some time and there has been no further trouble with the tunnel.

Owing to the space required for the work, it was necessary to suspend the use of the double track while it was going on, and a temporary track was laid through the center of the tunnel for the use of trains. The cutting out of the rock was done in short sections of about 1.20 meters each, and the masonry followed up as closely as possible the taking out of the stone. The work had to be done with a pick, because blasting would have caused further crumbling of the rock and occasion serious accidents.

To support the working stage and the centers for the arches there was used a wooden scaffolding resting upon wheels, which traveled on the outer rails of the two tracks temporarily abandoned; this scaffolding is shown in fig. 2. The free space above the stage was only 0.60 meter in height, and the masons could only work on their knees. Water worked through in quantities; it was carried off by movable gutters, but in spite of all precautions taken caused

much trouble to the workmen, who for some time had to adopt a waterproof dress.

The arch was built of brick and was for the most part 0.33 meter in thickness, but at some points where the water came through in large quantities it was increased to 0.44 meter, and there were made drains 0.16 meter diameter, as shown in fig. 3. The arch was covered by a cope 0.05 meter in thickness and by a layer of tarred felt, which was unrolled as the masonry was built up, as shown in fig. 4. The gap between this felt and the rock was filled in with stones worked in by hand.

In consequence of the very limited space, in which only a few men could work at a time, a little over five months was occupied in the work, and during that time a single track only, as noted above, was used through the tunnel. The train service was arranged by special order, home and distant signals being placed at each end of the tunnel, under the control of a special signal officer, and no accident whatever took place.

The work was done by contract, and cost in all 10,802 francs, or about 770 francs per running meter ($136 per yard); that is to say, very nearly as much as the cost per meter of a new tunnel.

THE DEVELOPMENT OF THE MODERN HIGH-POWER RIFLED CANNON.

By Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Continued from page 259.*)

Part II. Gun Construction in the United States.

I.—MATERIAL.

The fabrication of high-power ordnance in the United States is yet in its infancy. The small progress already made has only been reached through a long travail of experiment—experiment carried on in the persistent belief that cast iron was to be the cannon metal of the future. As in France, where they spent 120 years and wasted millions in the vain endeavor to get first-class work from a third-rate metal, we, for about the same period, followed in much the same lines; and that we have not wasted an equal number of millions is due more to the parsimony of Congress than to any want of willingness on the part of our gun-makers.

It is, of course, impossible to say how much of this persistent advocacy of cast iron, either alone or in combination with steel, is due to the influence of ordnance officers of the Army and Navy, and how much to outside pressure exerted upon Congress by the iron interests of the country. That it has had a strong following is well known, and that it still has earnest advocates is shown by the fact that we now have, for the land service, completed, undergoing construction or awaiting trial, one 12-in. cast-iron breech-loading rifle; a 12-in. cast-iron breech-loading rifle, hooped and tubed with steel; one of the same character lined with a steel tube, and a 10-in. cast-iron breech-loader, wrapped with wire.

That it would have been impossible 20 years ago to have procured in the United States steel forgings for even a gun of small caliber goes without the saying, and the same might be said up to five or six years ago; but there never was a good reason why, during this time, we should not have gone into the steel markets of Europe and bought rough forgings, as in the end we had to do, in order to make a beginning at gun construction.

II.—ARMY ORDNANCE.

During the war and the years immediately following its close—that is, up to 1870, there were made in the United States, in addition to the Parrott guns already referred to, three 8-in., one 10-in. and three 12-in. cast-iron, muzzle-loading rifles. These guns were cast at the South Boston and Fort Pitt foundries upon the Rodman principle of interior cooling, and were expected to show that American cast iron, properly manipulated, could be made to do duty in rifled as well as smooth-bore ordnance. They were, with two exceptions, subsequently all fired to extremity, with charges of only about one-tenth of the weight of the projectile. The fact that one of these guns was fired over 1,000 rounds, while another burst at the 27th, another at the 70th, and another at the 80th round, indicates the unreliability of the metal.

Beginning with 1870, the United States may be said to have been entirely destitute of heavy rifled ordnance. The Parrott rifles mounted in our sea-coast works were looked upon with more than suspicion, and nothing had yet been done looking to the rearmament of our forts and ships. Our dependence at this time was entirely upon smooth-bore guns—8, 10, 13, 15 and 20-in. Rodman, in the land service, and 9, 11 and 15-in. shell-guns (Dahlgren) in the Navy. Without the knowledge or facilities for the manufacture of steel in large masses suitable for gun construction, and, one might add, without the inclination to secure it abroad, recourse was had perforce to two methods—either a return to further experiments with cast iron pure and simple, or to a combination of cast iron strengthened with some other metal.

III.—CAST-IRON GUNS.

The appropriation bill of 1880 provided for the construction of four 12-in. cast-iron breech-loading rifles. Awaiting the action of the Getty Board on Heavy Ordnance, appointed the following year, the construction of these guns was postponed. Under the Act of 1883 one cast-iron breech-loader was authorized, together with those previously mentioned, to be made of cast iron reinforced with steel—one with a steel tube, another with a steel tube and hooks, and a third wire-wound. A wire-wound 10-in. steel gun was also authorized by the same Act. The contract for the casting of this gun, together with that of the bodies of the other iron guns authorized, was given to the South Boston Iron Works.

Of the 12-in. cast-iron gun, hooped and tubed with steel, just alluded to, and now under construction, much is expected by the advocates of composite guns. Fig. 1 shows the details of construction.

The 12-in. cast-iron rifle was finished in 1885, and turned over to the Ordnance Department for trial. In all 137 rounds have been fired from this piece, with a 265-lbs. charge of powder, and a projectile of 750 lbs. A velocity of 1,750 feet-seconds was obtained. At the end of the 137th round the bore was found to be so much eroded that further trial was considered unsafe, and the piece was withdrawn.

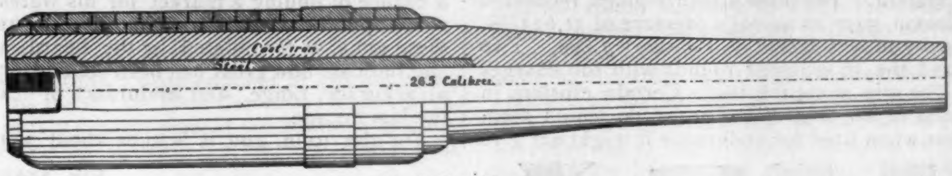
IV.—CONVERTED GUNS.

With the large number of cast-iron guns on hand, principles of economy here, as they had in France and Italy, led to the attempt to convert them into efficient rifles. It must be confessed that the results obtained were decidedly more satisfactory than abroad. Still the ballistic qualities of the converted guns were far below what we now have a right to expect of a rifle. The guns so converted were, however, a great improvement upon existing ordnance. The most that can be said against the system is that it undoubtedly delayed for nearly 10 years the development of the modern high-power gun.

The plan as originally proposed was to convert our 10, 13 and 15-in. smooth-bore Rodman guns into 8, 10 and 11-in. rifles by reboring and inserting a rifled wrought-iron tube of the required caliber. Experimental pieces of 8 and 9-in. caliber were first made, and these were followed by those of 10 and 11 in. Insertion of the tube from both the muzzle and breech was also experimented with. In the muzzle insertion the tube was held in place by a steel muzzle collar screwed into the casing or cast-iron body of the gun. With the breech insertion the piece was bored through its entire length, the tube inserted from the rear, and the breech closed by a steel breech plug. Corresponding shoulders upon the tube and casing gave longitudinal strength to the gun. As the result of these experiments the 8-in. gun was the only one recommended for service. Up to 1878 these guns were converted by insertion of the tube from the muzzle. But it was found that the coiled wrought-iron tube received insufficient support against

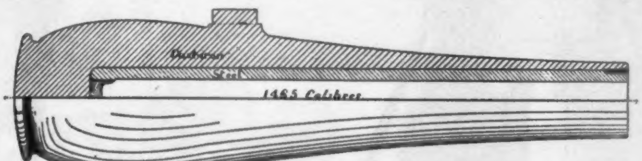
longitudinal stress from the muzzle collar alone. From this time up to 1884 breech insertion was employed; the tube, as before, being of coiled wrought iron. At the latter date steel tubes were substituted for those of wrought iron, and muzzle insertion again resorted to. In both systems of insertion a slight play was allowed between the tube and the body of the gun.

The conversion of these guns ceased in the following year—a total of something over 200 having been converted. The method of conversion is shown in fig. 2.



12-inch, 54-ton Army B.L. Rifle. Fig. 1.

Breech-loading pieces of 8 and 11-in. calibers were also constructed—13 and 15-in. Rodman guns supplying the shells. The tubes were of wrought iron, steel-jacketed, with the jacket prolonged sufficiently to the rear to receive the breech mechanism, which was of the wedge or Krupp pattern. These pieces were chambered to receive a considerably increased charge of powder. The steel forgings were procured in England. The first 8-in. gun stood a successful test of more than 600 rounds The test of an 8 in. and an 11 in. which followed (October, 1881) was not so satisfactory. The 8-in. gun burst at the 127th round, the 11 in. at the 18th. The failure of these guns had for the time being a disastrous effect both upon the use of steel in



8-Inch converted Rifle. Fig. 2.

gun fabrication and upon all breech-loading guns in general, and Krupp's system in particular, although the failure in both cases was shown to have been owing to a wretched quality of steel, on the one hand, and to faulty details of construction on the other. It gave, however, an additional lease of life to cast iron.

An 11-in. muzzle-loading chambered rifle was also constructed by conversion, in which both the tube and its jacket were of wrought iron. None of the calibers of converted guns mentioned can be considered as more than experimental, except the 8 in., which has become a service type. A number of converted breech-loaders of this

8-inch 13½ ton Army B.L. Rifle. Fig. 3

caliber were also finished, and form a part of our available armament.

V.—BUILT-UP GUNS.

Under Act of Congress of March 3, 1881, a Board on Heavy Ordnance and Projectiles, known as the Getty Board, was appointed to examine and report upon all plans for the fabrication of heavy guns and projectiles that might be submitted to it. The report of this Board was submitted the following year. It was decidedly non-committal in tone, and among a number of devices for gun construction recommended for trial, we find a half-hearted recommendation for an all-steel, built-up gun. The Senate Ordnance Committee of 1883, acting upon the recommendations of the Getty Board, among other things, approved of this recommendation, and the Act of that year authorized the construction of the first steel built-up breech-loading rifle.

The first essay was with a gun of 8-in. caliber. The forgings for the tube and jacket were ordered from Whitworth, the hoops from the Midvale Steel Works. This piece was assembled and finished at the West Point Foundry, and turned over for trial in 1886.

As originally constructed, the chase of this gun was only partly hooped. After firing some 20 odd rounds evidences of weakness appeared, and it was returned to the shop and the chase hooping extended to the muzzle. All future constructions are to have the chase hooped throughout. This may be considered a type gun, and the general methods of construction will undoubtedly be followed in the larger calibers. Fig. 3 shows the manner in which it is built up.

A 10-in. rifle of the same general design is now under construction, and is likely to be finished during the present year. The tube, jacket and trunnion-hoop come from Whitworth, the hoops from the Cambria Iron Works.

In addition to these guns, a 12-in., 45-ton, and a 16-in., 115-ton steel breech-loaders have been designed for the Army.*

VI.—CAST-STEEL GUNS.

In March, 1887, Congress appropriated some $20,000 for the purchase of three rough-bored and turned cast-steel 6-in. guns, one to be of Bessemer, one of open-hearth, and one of crucible steel; the guns to be finished at the Washington Navy Yard, and tested at the Naval proving-ground. The Pittsburgh Steel-Casting Company supplied a Bessemer casting, and the Standard Steel-Casting Company, of Thurlow, Pa., one of open-hearth steel, under this appropriation. No proposals for a crucible-steel gun were received.

With regard to these guns, it was specified that they should be composed of steel of domestic manufacture, made from the best quality of raw material, each to be of one piece, except the breech-plug—and the trunnion-band if desired—and to be unforged.

In their proposals both bidders promised, as regards test specimens, a tensile strength of 80,000 lbs. per square inch, an elastic limit of 40,000 lbs., and a finished weight of 11,000 and 12,000 lbs. for the Pittsburgh and Thurlow guns respectively.

As the result of the tests made at the Washington Navy Yard, eight in number for each gun, specimens taken from both breech and muzzle, we find the average tensile strength shown by all the tests to be 80,293 lbs. for the Pittsburgh and 80,322 lbs. for the Thurlow gun, with corresponding elastic limits of 49,269 and 38,024 lbs. per square inch.

* The difference between a high-power gun and one of the old pattern cannot be better shown than by comparing our Army 8-in., 13½-ton breech-loading steel rifle with the converted guns of the same caliber of 8 tons weight. The data of the converted gun are as follows: Charge, 27 lbs.; shot, 183 lbs.; initial velocity, 1,200 feet-seconds; pressure, 2,700 lbs. per square inch; muzzle energy, 1,871 foot-tons. The built-up rifle: Charge, 110 lbs.; shot, 300 lbs.; initial velocity, 1,860 feet-seconds; pressure, 3,580 lbs.; muzzle energy, 7,195 foot-tons. The 7,000 against the 1,800 foot-tons of energy tells the story.

The statutory proof of these guns was to be 10 rounds fired as rapidly as possible, with full service charge of 48½ lbs. and a projectile of 100 lbs., and an initial velocity of 2,000 feet-seconds.

The Bessemer gun was tested on December 5 of last year. A preliminary round with reduced charge was fired to set the gas-check. The piece was then loaded with the full charge of 48½ lbs. of powder and a 100-lbs. shell. The gun burst, breaking up into many fragments. So far as could be discovered at the time, no special defects in the metal were apparent. The three pressure-plugs, recovered after the explosion, gave an average pressure of 31,623 lbs.

The Thurlow gun was tested on February 7 last. Two preliminary and the 10 required rounds with full charges were fired. The gun stood the test. Certain erosions in the bore in front of the seat of the projectile would seem to indicate that when fired for endurance it might not give so good an account of itself. The estimated pressure was 15 tons per square inch.

In the Act of Congress approved in September last, we find the first decided step looking toward the construction of a permanent system of ordnance for the Army. Under its provisions a board of four officers, with the Commanding General of the Army at its head, and known as the Board of Ordnance and Fortifications, was appointed to supervise and direct the very liberal appropriations made by the Act.

First, we find an appropriation of $700,000 for the necessary structures, machinery, and tools for an Army Gun Factory, for finishing and assembling heavy ordnance, to be erected at the Watervliet Arsenal, West Troy, N. Y. Following this, $500,000 is appropriated for the completion of guns under fabrication, and for the tests of guns and carriages; $1,500,000 is set aside for the purchase of rough-finished, oil-tempered, and annealed steel for high-power coast-defense guns, of 8, 10, and 12-in. caliber; $250,000 for 12-in. breech-loading mortars, cast iron hooped with steel; and, finally, an appropriation of $6,000,000, to be expended at a rate not exceeding $2,000,000 a year, for the purchase of breech-loading steel guns of 10 and 12-in. caliber from private parties, such guns to be of a weight and dimensions prescribed by the Board, and to be tested by the same.

Here we find a new departure from the methods heretofore followed. Every gun-maker in the country has now a chance of finding a market for his wares, provided they come up to the required standard. The requirements for these guns, as formulated by the Board, are interesting, and indicate how great has been the advance in the matter of accuracy, range, and endurance of heavy guns within the last decade.

For the 10-in. gun it is to be about 30 tons in weight; 34 calibers length of bore; possess a muzzle energy of not less than 15,000 foot-tons; a range at 20° elevation of about eight miles; pass an endurance test of 300 rounds with full charges, and, as to accuracy, be able to put 25 per cent. of its shots within a vertical rectangle, 1.4 ft. by 1 ft., at 1,500 yards range, and within a horizontal rectangle, 48.5 yards by 9.2 yards at 10,000 yards range. The projectile is to weigh 575 lbs., and a rapidity of fire of 15 shots per hour be attainable.

The 12-in. gun is to have a weight of about 52 tons; a length of bore of 34 calibers; a muzzle energy of 26,000 foot-tons; a range of about 8½ miles at 20° elevation; the accuracy to be the same as that given for the 10-in. gun, and it must pass an endurance test of 250 rounds with full charges. The projectile is to have a weight of about 1,000 lbs., and the gun be able to fire at least 10 shots per hour.

(TO BE CONTINUED.)

Fig. 158.

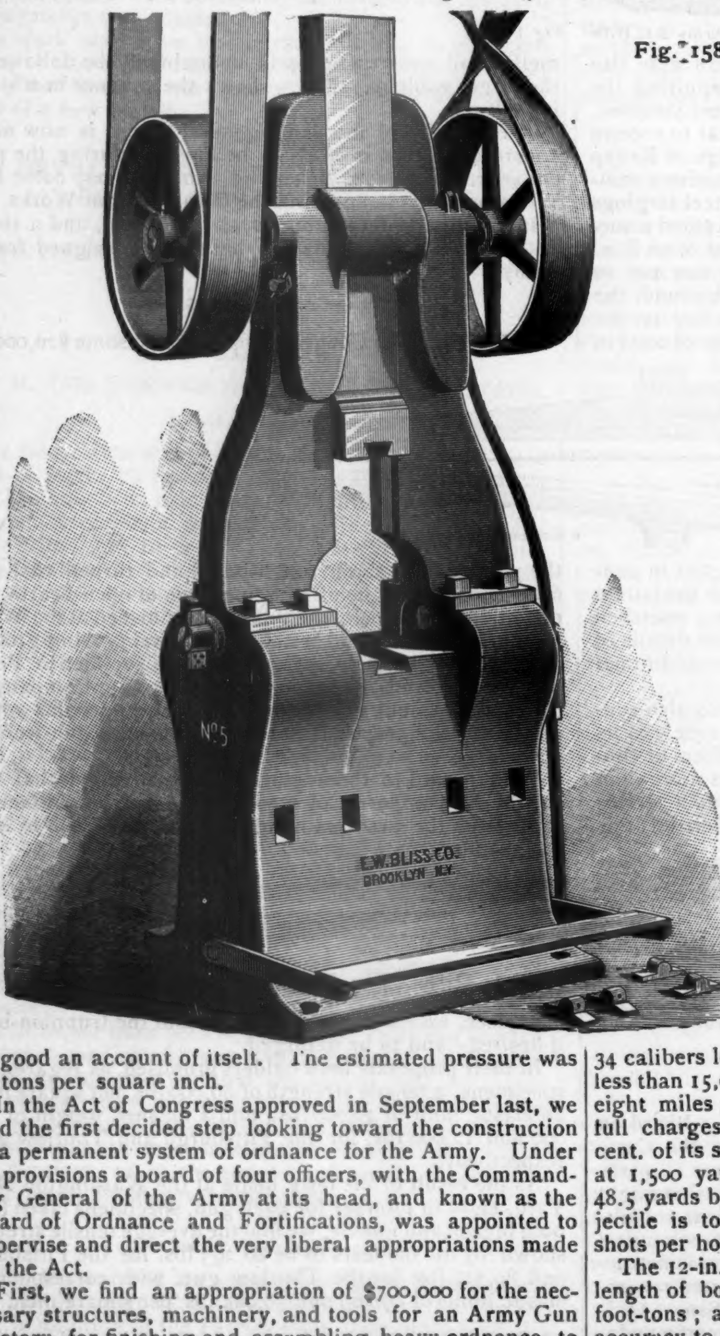
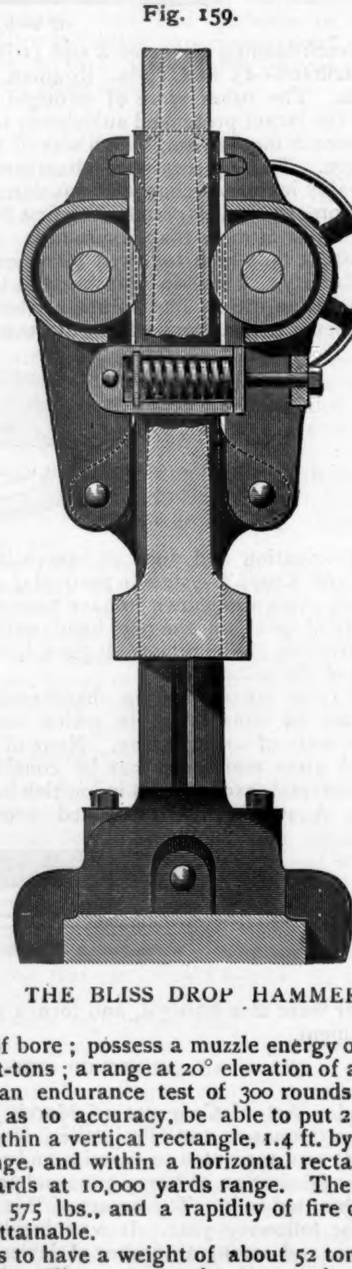


Fig. 159.



THE BLISS DROP HAMMER.

NOTES ON STEAM HAMMERS.

By C. Chomienne, Engineer.

(Translated from the French, under special arrangement with the Author, by Frederick Hobart.)

(Continued from page 265.)

CHAPTER LII.

THE BLISS DROP HAMMER.

Figs. 158 and 159 show a drop hammer or forging press, manufactured by the E. W. Bliss Company, of Brooklyn, N. Y. Fig. 158 is a general view of the hammer, and fig. 159 is a cross-section showing the manner in which the lifting rollers work.

The general construction of the hammer, dies, etc., does not differ materially from other hammers of the same kind, and can readily be seen from the illustrations. The rollers by which the hammer is lifted are worked by two pulleys, both run from the main shaft, one by a straight and the other by a crossed belt. The main point of difference between this and other drop hammers is the absence of any strap, board, or other attachment for the purpose of lifting the hammer. The hammer is forged of steel, and is of great length, so that the blow is concentrated over the work, which receives the entire effect resulting from its weight, and there is the further advantage that the bearings of the hammer on the guides is so extended that there is no danger of breakage when it is called upon to strike a glancing or side blow. The long bearing not only diminishes the chance of breaking the hammer, but of the guides also, as it prevents them from receiving a shock at any one point, the effect being distributed over their length. The friction rollers, instead of working on a belt or board, act directly upon this long body of the hammer itself. These rollers are carried in housings, as shown.

Instead of eccentrics or wedges a powerful compression spring is used to hold the rollers together, the arrangement of which is shown in fig. 159.

This spring device, it is claimed, has the advantage that any slight irregularity or lack of parallelism in the faces of the hammer does not interfere with its proper working, as the spring adjusts itself to such inequalities and keeps the pressure of the rollers uniform. As the rollers only require to be set back about ⅛ in., to free the hammer and allow it to fall, the spring is not liable to breakage or set, the limits of its action being so small.

The device for throwing away the rolls from the hammer and for securing the latter when at the top of its stroke is a very simple one ; a long incline is placed on each side, as shown by dotted lines in fig. 159, and brass shoes are attached to the housings in which the rolls are carried in such a manner that when the hammer arrives at top of its stroke these inclines come in contact with the brass shoes, wedging the rolls apart and clear of the hammer. The pressure of the springs is thus transferred from the rolls to the stationary shoes, and the hammer is prevented from dropping back. In this way no latch or dog is required to hold the hammer in position when lifted to its full height. No bolts or screw-threads are used in the construction of the lifting device.

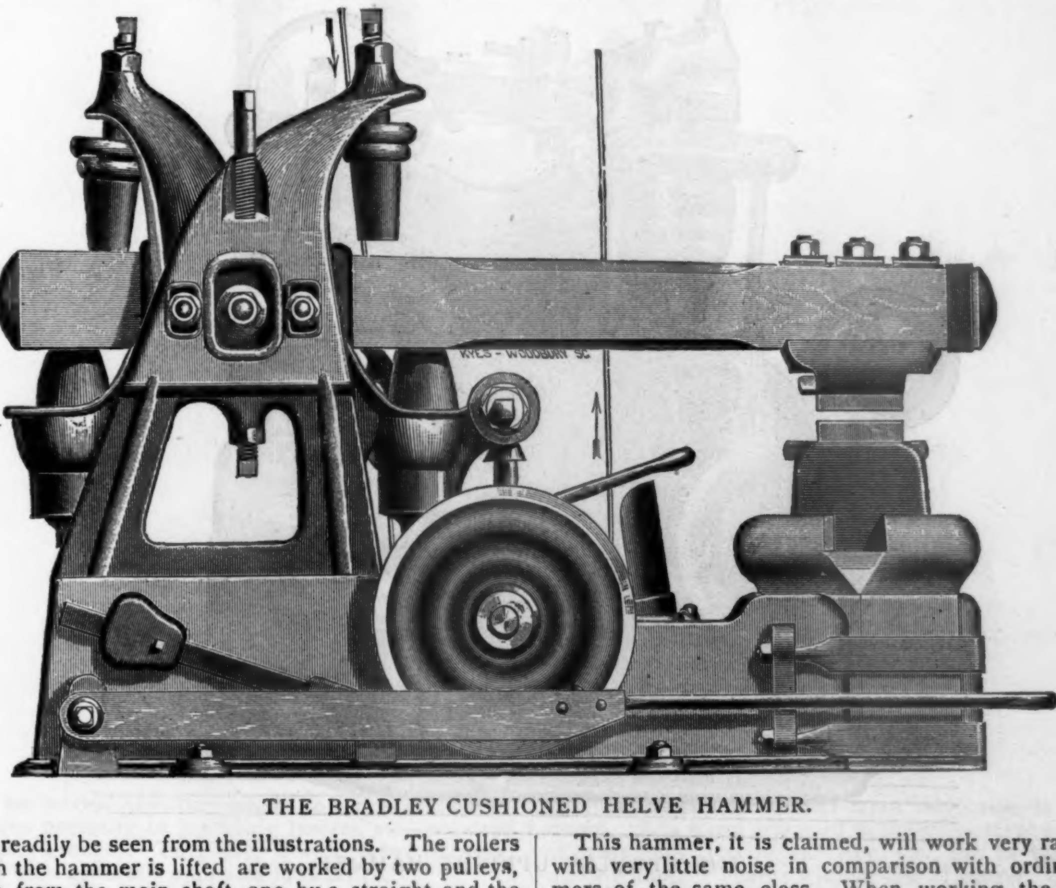


Fig. 160.

THE BRADLEY CUSHIONED HELVE HAMMER.

This hammer, it is claimed, will work very rapidly and with very little noise in comparison with ordinary hammers of the same class. When working the rolls are thrown apart, and the hammer is allowed to drop through the action of the treadle or foot-lever, shown in fig. 158 ; it can be dropped from any height desired, thus regulating the force of the blow.

These hammers are built in a variety of different sizes, from a small drop used for light work up to a hammer weighing one ton.

CHAPTER LIII.

THE BRADLEY HAMMERS.

Fig. 160 shows a helve hammer made by Bradley & Company, of Syracuse, N. Y., and known as the Bradley Cushioned Hammer, which has come into very extensive use in the United States for general forging purposes. This hammer is of the class known as helve hammers, which are, for a number of purposes, preferred to the drop or direct-acting hammer. The frame is made of cast iron ; the helve is made of hickory wood, the hammer-head being attached to it by heavy bolts. It is hung upon two adjustable hardened steel centers, carried in the frame, and

derives its motion from an eccentric, consisting of an iron hub, a bronze shell and a steel strap, which is carried upon the driving-shaft. This driving-shaft is run by a belt, and is also provided with a heavy balance wheel, to which is attached a brake.

The connection between the oscillator and the helve is by a short connecting-rod provided with an adjustable sleeve-nut, so that the lift or stroke of the hammer can be readily and quickly changed at the will of the operator, and the hammer can be made to give a light or a heavy blow, as required.

The bearings of the main shaft are made of bronze, and all the others of the best anti-friction metal. The husk containing the helve can be easily raised or lowered to admit of the use of dies, varying an inch or more in thickness, without shimming up the ends of them, thus preserving the key-ways and hammer-head bolts, an advantage which will be fully appreciated by practical mechanics. that the hammer is completely under the control of the operator.

On removing the pressure the hammer is instantly stopped with the helve up, by means of the brake acting on the balance-wheel, leaving the dies apart so that the hammer is again ready for instant use.

Fig. 161 shows the Bradley Upright Hammer, which is made by the same firm, and which has some modifications in design from the helve hammer. In the upright hammer, as will be seen from the illustrations, the driving-shaft and its connecting-rod are placed on the rear end of the frame; the hammer runs in guides carried on an arm projecting from a frame in front of the helve. Instead of being entirely of wood, as in the large hammer, the helve is made with a strap end, the connection with the hammer-head being made by a spring joined on two bolts, one at each end. This strap construction of the helve is used by the makers for all hammers up to 200 lbs. weight. For a light

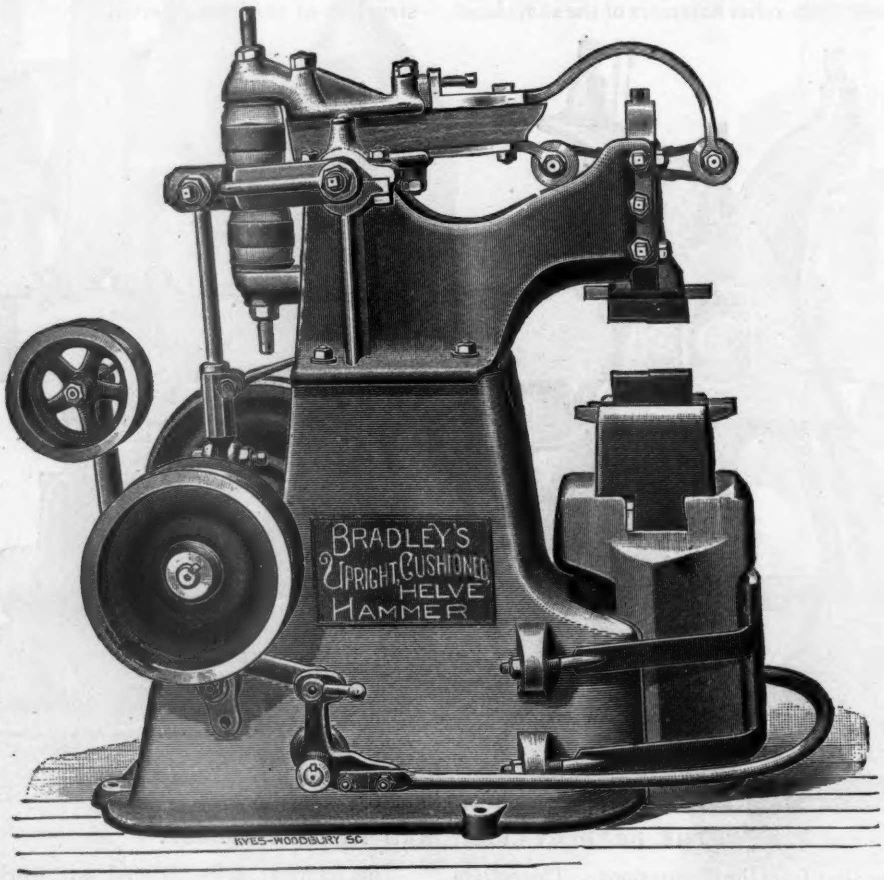


Fig. 161.

THE BRADLEY UPRIGHT HAMMER.

The oscillator and arch carry rubber cushions, so arranged as to relieve all the parts from the strain and jar caused by the concussion of the blow, besides adding materially to its power and elasticity. The tension of the rubber cushions can be regulated by means of set-screws in the upper and lower sockets of the oscillator.

The anvil-block and its foundation are entirely separate from the hammer proper, and the entire jar and concussion of the blow is received on the anvil alone, relieving all the other parts from the strain which they would otherwise sustain.

All the parts are so proportioned and so adjusted that the dead weight of the blow is evenly distributed through the parts intended to receive it.

A treadle around the bed of the hammer allows the hammerman, no matter how inexperienced, standing in front or on either side to apply the power, a gentle pressure of the foot bringing the tightener pulley in connection with the belt on the driving-pulley, from which the power is derived. The speed and power of the stroke may be varied according to the pressure applied to the treadle, so hammer this construction presents the advantage of greater compactness, the whole hammer really taking up very little more space than an ordinary smith's forge. The general principles of the adjustable connecting-rod, the eccentric motion, the fly-wheel with its brake, the regulation of the motion by a treadle, and the separate anvil-block are preserved in this hammer, the modifications being chiefly in detail. As will be seen from the cut, there is a circular opening in the frame opposite the hammer-head, which permits the handling of long bars under the hammer.

Fig. 162 shows the Beaudry Upright Power Hammer, which is built by the same firm. In this hammer, as in the other upright hammer, guides are provided in which the hammer works. The helve is forked, or made double, and is connected to the hammer by a spring or heavy strap passing over pins at the ends of the forked-arm and through a slot in the hammer-block. The helve works on large bearings carried on a frame. The driving-shaft with its eccentric is placed at the rear of the frame, and the connecting-rod is supplied with a long sleeve-nut by which

its length can be adjusted. This connecting-rod works on a projecting pin forming the rear end of the helve, but made separate from it and connected to the forward part by two bolts passing through rubber springs, which have some of the cushioning effect found in the Bradley hammer, but in a different form. The motion of this hammer is regulated by a treadle which acts through a tightening pulley, pressing it against or relieving it from the main driving-belt as required. As in the Bradley hammer, the anvil-block is separate from the frame, freeing the latter from shocks.

The construction of this hammer, which is really very simple, can be readily understood from the engravings.

These Bradley hammers are very largely in use for general forging and die work, and will be found in manufactories of arms, sewing machines, tools, agricultural instruments, and, in fact, for general forging work of all kinds. They are exceedingly useful tools, both for special purposes and for general work, and have the advantage that

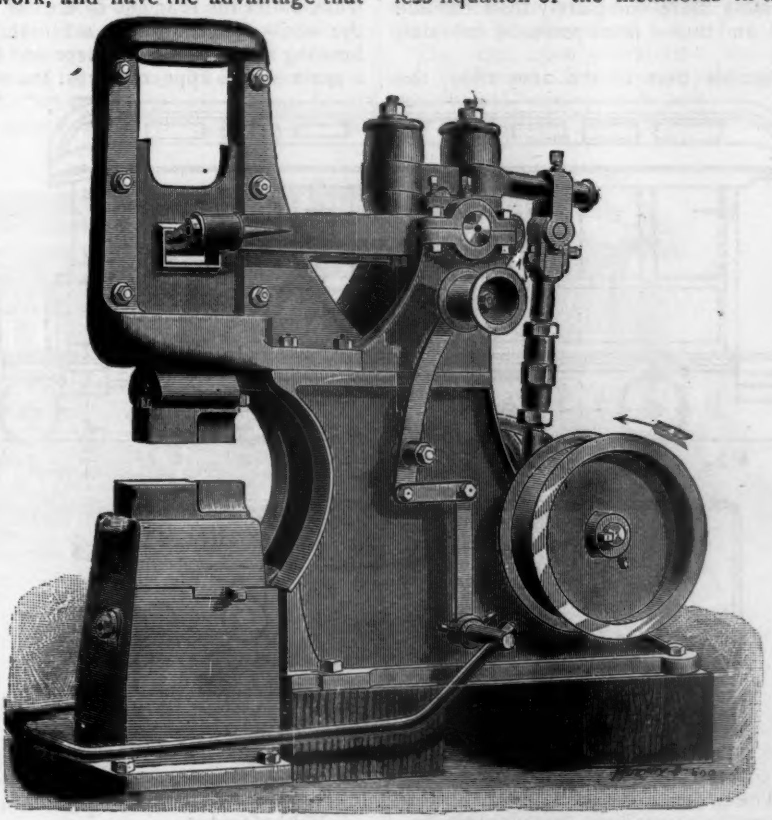


Fig. 162.

THE BEAUDRY UPRIGHT HAMMER.

they can be erected anywhere where power is attainable, without the necessity of providing boilers, etc., required for a steam-hammer. They have a wide range of work, and have been generally approved in practice.

(TO BE CONTINUED.)

NICKEL-STEEL.

(Condensed from paper by James Riley, read before the British Iron and Steel Institute).

In this paper the Author stated the result of an examination made into the new alloy of nickel and steel, made at the request of the inventors. He had visited the works in France, and seen the process of manufacture, in order to judge of the degree of certainty with which the desired product could be obtained from the crucible. Subsequently the patentees visited the works with which the Author is connected, and various charges were made, which showed that the composition of the alloy could be as effectually controlled in the open-hearth furnace as in the crucible. His experience led him to conclude that the alloy can be made in any good open-hearth furnace working at a fairly good heat. The charge can be made in as short a time as an ordinary scrap charge of steel—say about seven hours. Its working demands no extraordinary care ; in fact, not so much as is required in working many other kinds of charges, the composition of the resulting steel being easily and definitely controlled. No special arrangements are required for casting, the ordinary ladles and molds being sufficient. If the charge is properly worked, nearly all the nickel will be found in the steel, and almost none is lost in the slag ; in this respect it is widely different from charges of chrome-steel. The steel is steady in the mold, it is more fluid and thinner than ordinary steel, it sets more rapidly, and appears to be thoroughly homogeneous. The ingots are clean and smooth in appearance on the outside, but those richest in nickel are a little more "piped" than are ingots of ordinary mild steel. There is less liquation of the metalloids in these ingots, therefore liability to serious troubles from this cause is much reduced. Any scrap produced in the subsequent operations of hammering, rolling, shearing, etc., can be remelted in making another charge without loss of nickel. No extraordinary care is required when reheating the ingots for hammering or rolling. They will stand quite as much heat as ingots having equal contents of carbon but no nickel, except perhaps in the case of steel containing over 25 per cent. of nickel, when the heat should be kept a little lower, and more care taken in forging. If the steel has been properly made, and is of correct composition, it will hammer and roll well, whether it contains little or much nickel ; but it is possible to make it of such poor quality in other respects that it will crack badly in working, as is the case with ordinary steel.

A table appended to the paper gives the result of tests of 12 different specimens of the alloy, with nickel varying in proportion from 1 up to 49.4 per cent.

The quality of hardness obtains as the nickel is increased, until about 20 per cent. is reached, when a change takes place and successive additions of nickel tend to make the steel softer and more ductile, and even to neutralize the influence of carbon. A series of hardening and tempering tests show the possibility of very largely raising the break-

ing strain and elastic limit, and the hardness of these alloys.

One piece tested gave: Breaking strain, 95.6 tons; elastic limit, 54 tons; extension (in 4 in.), 9.37 per cent.; contraction of area, 49.2 per cent. Other pieces gave nearly parallel results.

The new alloy has an advantage over ordinary steel, because it does not so easily corrode. Steels rich in nickel are, in fact, non-corrodible; and those poor in nickel are still much better in this respect than ordinary steel.

Alloys up to 5 per cent. of nickel can be readily worked in the lathe or planer, but richer alloys are more difficult to work. Poor alloys stand punching very well. The 1 per cent. nickel steel welds fairly well, but richer alloys do not weld easily.

The Authór then refers to the theory regarding the molecular constitution of the alloy. It was supposed that it consisted of crystals of metallic iron, cemented together by carbide of iron and nickel, which "cement" fills the space between the crystals more completely than carbide alone in ordinary steel, and thus a more powerful cohesion is obtained.

Referring to the possible uses of the new alloy, the Author thought that the richer alloys would be extensively employed in the field covered by what is usually termed the "metal trades." The 25 per cent. alloys he considered well adapted for all operations entailing considerable deformation, such, for instance, as deep stamping and flanging, while their non-corrodibility will render them useful in all cases where the cost of metal is of minor importance as compared with the cost of labor. Alloys containing between 25 and 5 per cent. of nickel might be used for tool steel, but the alloys containing less than 5 per cent. will have a more general application. Recent advances in marine engineering had only been possible because in steel the engineer had a superior metal at his command, and improvement in the same direction was bound to follow from the introduction of a new material even better than steel. A metal having when annealed an ultimate strength some 30 per cent. higher than steel, and an elastic limit some 60 to 70 per cent. higher, with equal ductility and less liability of corrosion, offered very large advantages. The new metal was also very valuable for armor-plates, and the Author exhibited a small armor-plate made of nickel steel.

In the discussion it was stated that gun-barrels made of nickel-steel stood very high tests. A 6-in. gun of this metal had been ordered by the English Government.

An objection suggested in the discussion was the cost of nickel, and the fact that the commercial metal was usually impure, containing copper and silicon. This objection, however, was not considered important.

AN INSPECTION LOCOMOTIVE.

THE accompanying illustrations show a small inspection locomotive, or combined locomotive and car, recently built by the Schenectady Locomotive Works for the Delaware & Hudson Canal Company, and intended especially for the use of the Superintendent of the lines of that Company. In these illustrations, fig. 1 is a perspective view, fig. 2 is a sketch of the elevation, showing the position of the boiler, etc., and fig. 3 is a plan, showing the arrangement of the locomotive and car.

As shown on the elevation, the length of the engine, measured between the extreme points of the two pilots, is 41 ft. 5 in.; the extreme wheel-base is 26 ft., and the rigid wheel-base, measured between the center of the four-wheeled truck and the center of the driving-wheels, is 14 ft. 2 in. It is carried on a single pair of driving-wheels, a two-wheeled or pony truck in front and a four-wheeled truck under the rear end of the car. The car body extends the whole length of the machine, the forward end thus forming a cab for the engineer and fireman, and preserving a symmetrical appearance for the whole.

Fig. 2.

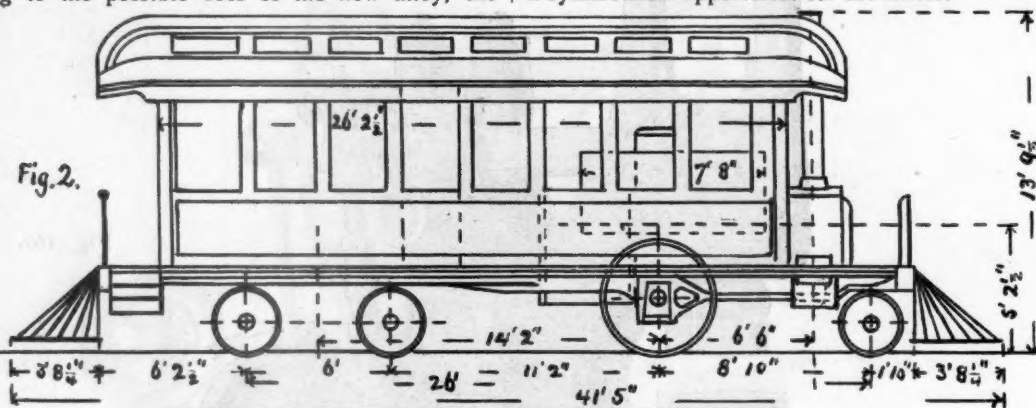
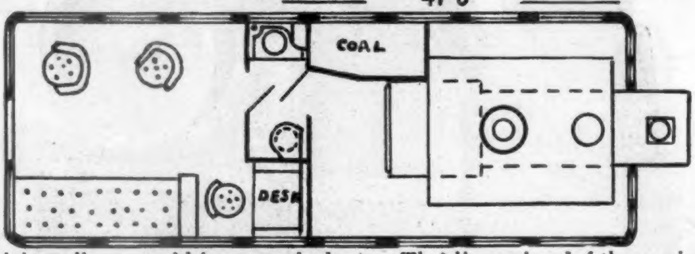


Fig. 3.



The dimensions of the engine are as follows:

Diameter of boiler	36 in.
Length of fire-box	40 "
Width of fire-box	36¾ "
Depth of fire-box	44 "
Number of tubes	102
Outside diameter of tubes	1¾ in.
Length of tubes	6 ft. 6 "
Grate surface	10.2 sq. ft.
Heating surface, fire-box	46.5 " "
Heating surface, tubes	299.8 " "
Heating surface, total	346.3 " "
Material of boiler	⅜-in. steel
Diameter of cylinders	9 in.
Stroke of cylinders	16 "
Size of steam-ports	7 × 0⅞ "
Size of exhaust-ports	7 × 1½ "
Outside lap of valve	0½ "
Inside lap of valve	0$\frac{1}{32}$ "
Throw of eccentrics	3⅝ "
Greatest travel of valve	3¾ "
Diameter of driving-wheels	54 "
Diameter of front truck-wheels	28 "
Diameter of back truck-wheels	30 "
Size of driving-axle journals	6 × 8 "
Size of front truck journals	4½ × 8 "
Size of back truck-journals	3¾ × 7 "
Total weight in running order	63,000 lbs.
Total weight on drivers	26,000 "
Water capacity of tank	500 gals.
Coal capacity of fuel-box	2,000 lbs.

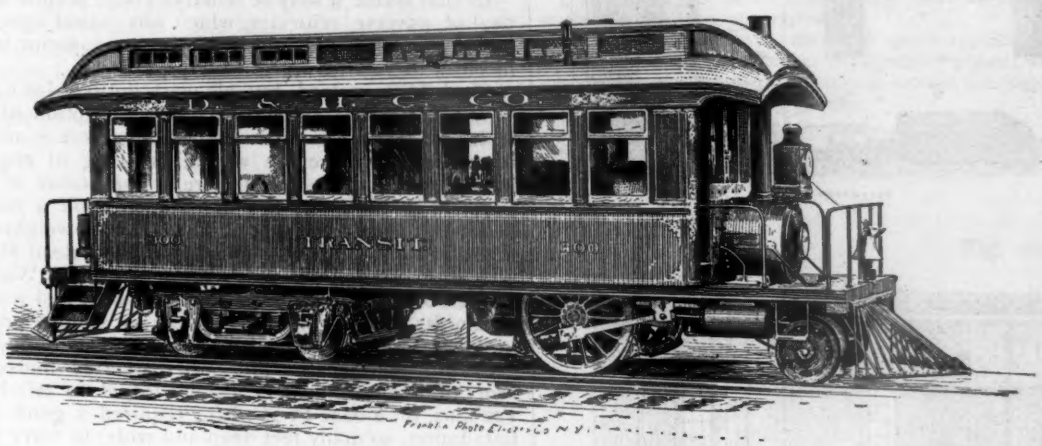
The front truck is of the swing-bolster pattern, and the back or four-wheeled truck of the rigid-center type. The engine will pass with ease curves of 300 ft. radius.

The water is carried in a saddle tank 7 ft. 8 in. long, which is placed over the boiler, as shown in the sketch, and the coal in a box in the engineer's compartment of the car.

The car is abundantly provided with windows at the side, as shown. At the rear end, and opening on the platform, the windows at each side of the door and also in the door are of heavy plate-glass, and extend to within 1 ft. of the floor, affording an unobstructed view of the track. A large window between the inspection-room and the engine-room gives the engineer a clear view of the road when running, with the inspection-room end of the locomotive forward. The inspection-room is 9 ft. 6 in. long by the full width of the car, and is fitted with a toilet room complete; wth a writing-desk, three drawing-room car seats, a sofa, and a full outfit of lamps, books, etc. The inside wood-work is of mahogany, and the room is finished in handsome style. The general arrangement is shown in the plan; the lounge is movable, and can be made into a bed if required at night. The chair shown between the desk and the lounge on the plan is not fixed to the floor, but can be moved whenever required, and, as will be seen, there is room to put in additional chairs should they be needed at any time.

This engine has frequently made 45 miles an hour, and has been run up to 60 miles an hour; the provision of coal and water is sufficient for a long run, and everything necessary for a protracted trip over the road can be carried.

The whole arrangement is very complete, and very well designed for the purpose for which it is intended. Since it has been delivered to the Delaware & Hudson Canal Company it has been in constant use, and has given excellent satisfaction.



INSPECTION LOCOMOTIVE.

BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS.

THE CLARK MILLS FURNACE—A REMINISCENCE.

By A. Vivarttas.

Clark Mills built a furnace: a furnace not described in the books, but which should be. Who was Clark Mills? How came he to build such a furnace? And what was that furnace like?

Clark Mills, to tell the story in nearly his own words, was born in New York State, some 12 miles or so from Utica, and had relatives living there at the time of the narration.

He was twice married, having by his first wife four sons. While yet a young man he drifted out to Charleston, S. C., where he followed the trade of plastering, and finished the walls of interiors with scagliola. Business getting dull, he became somewhat interested in politics. But one night, after a consultation with some of the leaders, he found when he started to go home that he could not walk straight. He stopped, and leaned against a hitching-post until he could walk erect. Meantime he thought that this had gone far enough; it was time to make a change. Plastering was dull, but he could handle plaster, and it must pay him somehow.

At that time there lived in Charleston a saddler and harness-maker, who was one of the characters of the place, and who, by a habit of drawing his mouth to one side as he stretched his stitches, had got a comical kink in one side of his face. Clark Mills got him for his first subject, and modeled his portrait in plaster. The likeness was universally recognized and approved; Mills soon got a commission for a bust, charging the modest price of $20. The business grew; he raised his price to $25, and in a few months some Charleston gentlemen, who were willing to encourage home talent, raised a subscription to enable him to make a bust of John C. Calhoun, who was then very popular there.

The bust, upon completion, was given to the city, and the Municipal Government presented Mr. Mills with a gold medal valued at $2,000. His friends now advised him to visit Italy, and a fund was raised for that purpose, and he started; but visiting Washington on his way North, the Committee of Congress, who had in charge the matter of a proposed equestrian statue to Andrew Jackson, asked him to offer a design therefor. He had never attempted such a subject, and declined; but the idea ran in his head, and after sleeping over it he determined to try, and making a small model, submitted it to the Committee.

It was accepted, and he received the commission, the price to be $12,000. Mills now set to work on a full-sized model, and communicated with the brass-founders, for the statue was to be of bronze; the Government having agreed to supply some old guns that had been brought from Mexico for the purpose.

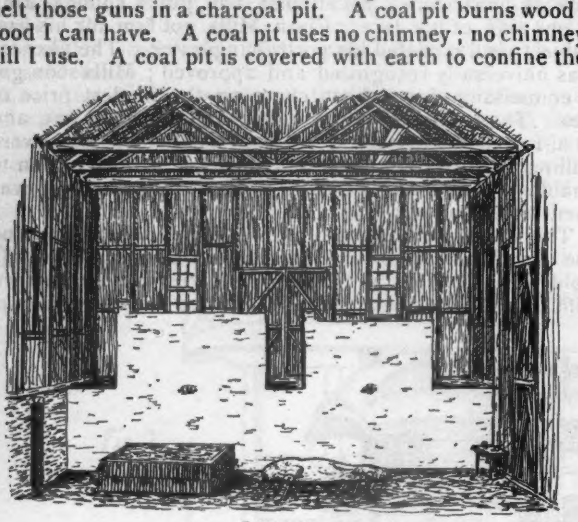
But none of the American founders would take so large and difficult a job at any price that Mr. Mills felt justified in paying, and so he started in to learn the brass-founder's business, to cast it himself. The Government would let him use the furnaces at the Navy Yard; but when the authorities there found that he wanted to dig a pit 15 ft. deep, to sink his mold below the furnace level, they became alarmed for the safety of the foundations of the furnace, and he determined to construct a furnace of his own.

So Clark Mills came to build a furnace. This Mr. Mills was blest with a fairly good memory, and studying over the best authorities upon the subject of bronze-melting, he came to the conclusion that their plans were unnecessarily expensive. And he bethought him how, when a boy of 15, he had been with a gang of men burning charcoal, and how the lost log chain was found when the pit was burnt and emptied, it having been accidentally covered in the bottom of the pile, and lain there through the burning.

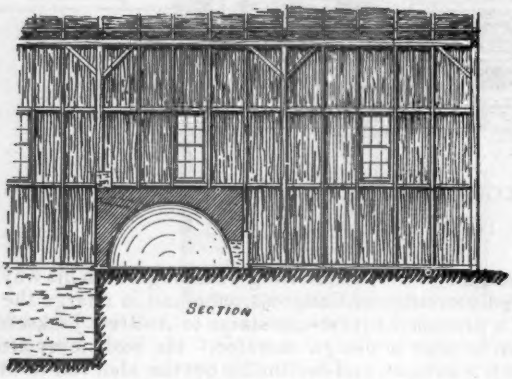
But of that log chain Clark Mills also recollected that not only were the wrought-iron links melted and run together, but that pieces of brick that lay in contact with them were also melted, and so fused with the iron that they could not be separated nor distinguished from each other at the juncture.

Said Mr. Mills, "I had heard ministers preach of hell, and I wondered how much hotter hell was than the bottom of a charcoal pit."

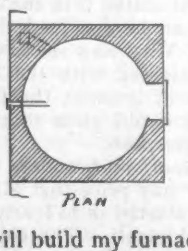
Anyway Mr. Mills, wanting a bronze furnace, remembered his youth, and he took courage and said, "I will melt those guns in a charcoal pit. A coal pit burns wood; wood I can have. A coal pit uses no chimney; no chimney will I use. A coal pit is covered with earth to confine the



ELEVATION



SECTION



PLAN

heat and gases; I will build my furnace of brick or baked clay, that it may retain its form for another time. In that alone will I depart from the charcoal pit plan."

Mr. Mills commenced his furnace upon the ground where the south front of the Treasury Department now stands. He consulted the scientific men and authorities of the day. He stood alone; his plan was condemned unanimously as a scheme that could not possibly succeed. Among those who put themselves on record to that effect were Professor Joseph Henry, of the Smithsonian Institute, and Professor Page, of Washington. The latter not only condemned the plan of the proposed furnace, but also bitterly criticised the design of the proposed statue, asserting that if made as designed the statue would not have strength to hold up its own weight.

So much noise was made upon this point, that Mr. Mills made a small model of his design, and cast it in bronze without core, and visiting Professor Page set it before him, and asked him, "If this model, which is solid, stands upon its legs, as you see, why will not the large statue, with solid legs and hollow body, stand also?" Yet it may be mentioned that to this day there are those who imagine (falsely) that there are iron rods in the legs of that statue to strengthen them.

Clark Mills, however, with commendable firmness kept on his course and constructed his furnace, and at the first heat melted down 6,000 lbs. of bronze with three-eighths of a cord of pine-wood; casting four bells, one of which was sent to the Navy Yard, and one, I think, to the Smithsonian Institute. One he kept, and afterward used on his place near Bladensburg—the only bell, by the way, the writer ever heard time farm-hands to their work at 10 hours per day.

The writer has forgotten the location of the fourth of those bells. But when Mr. Mills told Professor Henry of his success, the Professor held up both hands with astonishment.

Mr. Mills now went on, and cast in this furnace the statue of General Jackson now standing in Lafayette Square, in front of the President's house, in Washington.

Of that statue it may be remarked that, in spite of a great deal of adverse criticism, which was based upon artistic and some political jealousy, it has no superior in artistic merit in the known world to-day.

Clark Mills is dead, but his work outlives his critics.

Without going into a detailed description of a work which all may inspect for themselves, there is one feature in connection therewith which, as being of engineering interest, should be noted here. The statue of General Jackson, in Lafayette Square, stands upon a monolithic pedestal measuring 15 × 15 × 18 ft., and weighing more than 120 tons. It is of granite from the State of Maryland, and was brought to Washington over the Washington Branch of the Baltimore & Ohio Railroad, and was, at the date of its erection in 1851, the heaviest stone ever handled in the United States; and it has few equals to-day.

In this matter also Mr. Mills asserted himself. His army of officious advisers did not forget to tell him that 120 tons, on a base 15 × 18 ft., required a good masonry foundation, so many feet deep and wide, to carry it.

Mr. Mills said, "A built-up pedestal might need a strong floor, to prevent unequal settling and consequent rupture; but I have seen many a bigger boulder lie upon the ground intact."

And upon the ground he set that pedestal; and after more than a generation we may say that he did well.

This statue having been finished and accepted, Mr. Mills found himself somewhat out of pocket, and Congress voted him about $25,000 additional.

He now secured an estate upon the Bladensburg turnpike, and erected a studio and foundry. The first studio, a wooden building, was destroyed by one of those sudden squalls that occasionally drop down upon the District of Columbia, rolling tin roofs up like carpets, and landing them carefully in the tops of trees, out of the way of the passers in the streets.

He rebuilt his studio of brick, and its large doors and octagon form made it a prominent landmark from both railroad and turnpike. On the other side of the railroad he located his foundry, and constructed therein two furnaces of his peculiar design; the accompanying cuts thereof are sketched from memory of many years, but are correct in all essentials. The larger furnace had a hearth of brick about 8 ft. in diameter, and was nearly hemispherical in its internal form. There was a door some 2 ft. square on one side at the bottom, which, with a small channel for drawing off the molten metal, and a chimney-flue about 8 in. square to assist in starting his fire, were all of the openings. The exterior was a plain brick block 10 ft. square and 6 ft. high, the chimney only rising about 16 in. more.

The smaller furnace was precisely similar in form and arrangement, but its inside diameter was only about 6 ft.

These furnaces were located, as shown, upon a bank wall 6 or 7 ft. high, thus obviating the necessity of digging pits

for his molds. The foundry was also supplied with ovens for drying molds and cores, two cranes, etc.

Here Mr. Mills cast the *replica* of his Jackson statue, which is now standing in the city of New Orleans, taking it out there and inaugurating it in the spring of 1856, some months before the statue of Washington, by Brown (the third equestrian statue cast in this country), was inaugurated in Union Square, New York. Mr. Mills also cast another of the Jackson statues, which was intended for Nashville, Tenn. But the Civil War intervened before the matter was consummated.

Here also Mr. Mills modeled and cast the statue of Washington, which stands in the circle as you go up Pennsylvania Avenue toward Georgetown. This was also a Government commission, and was inaugurated February 22, 1860.

The next year Mr. Mills let his foundry to the Government, and upon a salary cast and finished the statue designed by Crawford, which adorns the dome of the Capitol, and is popularly supposed to typify Columbia. In regard to this statue there is one curious point. The left hand of the figure rests upon a shield, generally supposed to be the escutcheon of the United States, but incorrectly bearing 13 stars in the "chief," which have no business there, and having 15 "pales" or stripes in the field, in place of the 13 which should be there. Mr. Mills, when this was pointed out to him, admitted the fact, but took no responsibility for the design he was carrying out, and afterward passed the matter off as of little consequence, while the majority of the people or Government officers could not correct him to-day.

perfect honeycomb of bronze, full of vitrified brick, with the marks of the slice-bar, where he had searched for his metal. It was about 8 ft. in diameter, and near a foot thick; when struck it would ring like a deep toned bell.

While casting the statue of Washington, in the fall of 1859, Mr. Mills gave two of his men an overtime job to break it up, he supplying the fuel—it being, of course, "hot short"—and sledges, and paying them so much a pound for the metal; and it kept them busy at night for some weeks.

CATECHISM OF THE LOCOMOTIVE.

(Revised and enlarged.)

By M. N. Forney.

(Continued from page 290.)

CHAPTER XXX.

THE EAMES VACUUM DRIVING-WHEEL BRAKE.

Question 736. *What difference is there in the principle of working of vacuum and air-brakes?*

Answer. In air-brakes the force which applies the brakes is exerted by air of a pressure considerably greater than that of the atmosphere, whereas in vacuum brakes the force is exerted by ordinary atmospheric pressure.

Question 737. *By what means is the atmospheric pressure exerted to apply the brakes?*

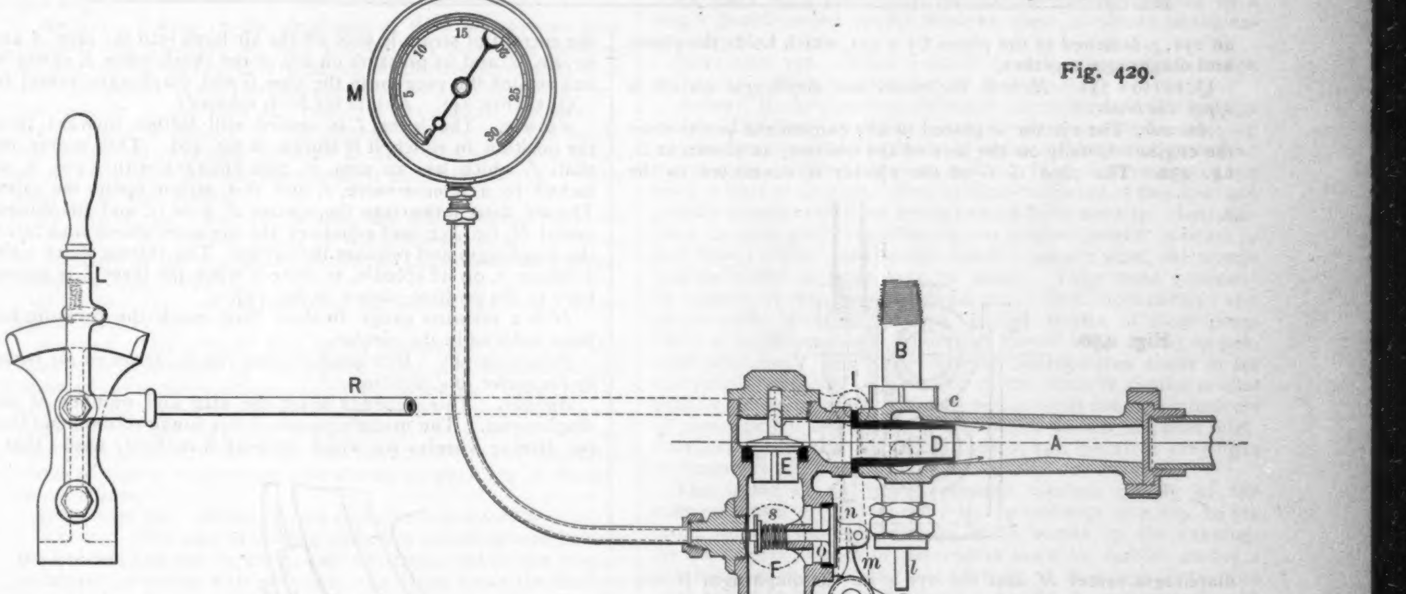


Fig. 429.

When Mr. Mills came to cast the statue of Washington, above mentioned, he wished to mix his own bronze, and then constructed reverberatory furnaces, which he used in casting both the statue of Washington and the apex of the dome of the Capitol.

With regard to the efficiency of the Mills chimneyless furnace, one incident may be told. It happened while casting the Jackson statue for New Orleans. One night the molds were ready, the heat and metal nearly ready to pour, when Mr. Mills was called into the house and detained for half an hour or more. Hurrying back, and concerned for his castings, he opened the door of the furnace and thrust in the slice-bar, to find his metal all gone, and the brick bottom of his furnace melted. He "shoveled it up like mush."

He was compelled to cool down, tear out the bottom or hearth of his furnace, and rebuild. That furnace bottom lay in the lot near the studio from 1856 to 1859, a

Answer. The air is exhausted from a cylinder or other vessel, so that the pressure of the atmosphere acts on the opposite side of a piston or diaphragm, and thus exerts the requisite force to apply the brakes.

Question 738. *How is the air exhausted?*

Answer. Usually by means of an instrument called an "ejector."

Question 739. *How is an ejector constructed and how does it operate?*

Answer. It consists of a tube, *A*, fig. 429, to which a current of steam is admitted by the pipe *B*. The steam enters the tube through the annular space *c c* around the internal nozzle *D*, as is indicated by the darts. This produces what is called an "induced current" of air through the tube *D*, or, in other words, the steam escaping into *A* draws the air in *D* after it, and thus produces a partial vacuum above the valve *E*, and the air pressure below raises the valve, and the air is then exhausted from the space *F* below it and from the pipe *G*, and from a diaphragm vessel, with which the pipe *G* is connected.

QUESTION 740. *How is the diaphragm arranged and how does it operate?*

Answer. Fig. 431 represents the diaphragm vessel *H*, the lower portion being shown in section. It has a wide open mouth, with a flange, *b b*, around it. This open mouth is covered by an india-rubber diaphragm, *d d*, which is attached to the flange *b b* by a ring below it and bolts shown in the engraving. The diaphragm has two metal plates in the middle, with an eye, *g*, fastened to the plates by a nut, which holds the plates and diaphragm together.

QUESTION 741. *How do the ejector and diaphragm operate to apply the brakes?*

Answer. The ejector is placed in any convenient position on the engine—usually on the side of the fire-box, as shown at *E*, fig. 432. The pipe *G G* of the ejector is connected to the diaphragm vessel *H*, and the eye *g* on the diaphragm is connected by a rod, *g h*, to the arm *h i*, which is attached to a shaft, *i*. This shaft has a short arm, *i j*, which is connected to the brake-shoes by a rod, *k*. *L* is the brake-lever located inside of the cab, and shown on an enlarged scale in fig. 429. Steam is admitted to the ejector by a valve, *v*, fig. 430, which is attached to the stem *l*. This valve is operated by means of the brake-lever *L*, fig. 429, which is connected by a rod, *R*, to an arm, *I J*. This arm is attached to a shaft, *J*, which has a short arm or toe, *K*, connected to it. When the lever *L* is moved backward or toward the left-hand side of the engraving, the toe *k* lifts the spindle *l* and valve *v*, fig. 430, which admits steam to the annular space *c c* of the ejector, and its escape produces a partial vacuum in the pipe *G* and diaphragm vessel *H*, fig. 432, as has been explained. When this occurs the air below the india-rubber diaphragm presses it upward, and this pressure is communicated to the brake-shoes through the connections *g h i j* and *k*. When the brakes have been applied sufficiently the lever *L*, fig. 429, is moved forward, or toward the right in the engraving, to the middle position in which it is shown. This lowers the toe *k* and allows the steam-valve *v* to close. When the current of steam is shut off the air flows into the pipe *A* and nozzle *D*, and its pressure on top of the check-valve *E* closes it, and retains the vacuum in the pipe *G* and diaphragm vessel *H*.

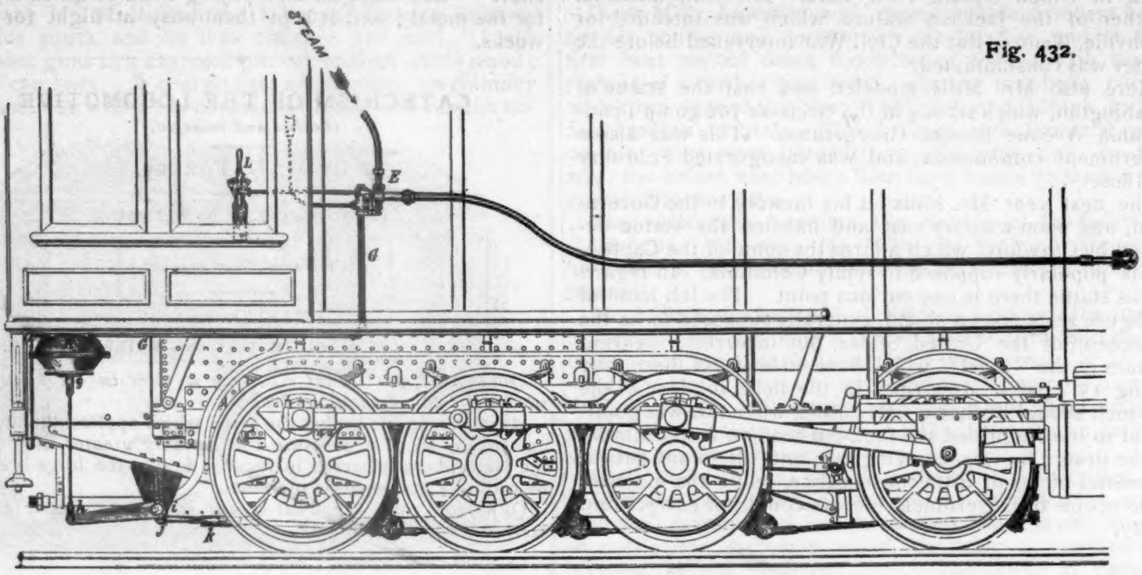


Fig. 432.

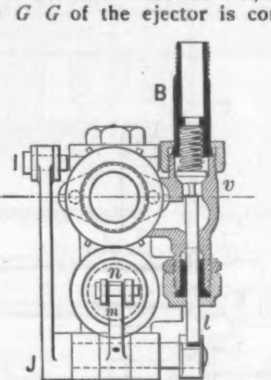


Fig. 430.

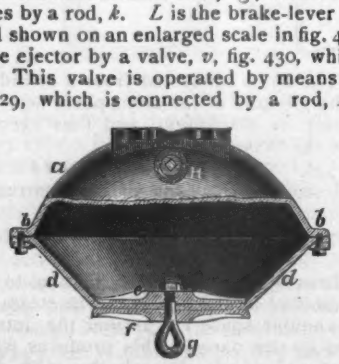


Fig. 431.

QUESTION 742. *How is the brake released?*

Answer. The lever *L* is moved still farther forward, from the position in which it is shown in fig. 429. This moves the shaft *J*, which has an arm, *m*, that engages with a pin, *n*, attached to a release-valve, *o*, and this action opens the valve. The air then flows into the ejector *F*, pipe *G*, and diaphragm vessel *H*, fig. 432, and equalizes the pressure above and below the diaphragm and releases the brakes. The release-valve *o* has a spring, *s*, on its spindle, to close it when the lever *L* is moved back to the position shown in fig. 429.

M is a pressure gauge to show how much the pressure has been reduced in the ejector.

QUESTION 743. *How much pressure can be exerted on the brakes by the ejector and diaphragm?*

Answer. This depends upon the size and number of the diaphragms. The manufacturers of this brake recommend that for driving-wheels—for which purpose it is chiefly used—that a pressure upon the brake-shoes equal to about 65 per cent. of the weight on the wheels should be employed.

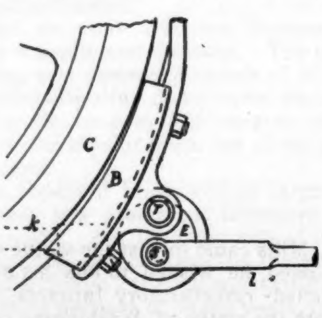


Fig. 433.

QUESTION 744. *How is the pressure on the brake-shoes of the different wheels equalized?*

Answer. The rod *k*, fig. 432, is connected to a circular disc, *E*, fig. 433, which has two shafts or spindles, *r* and *s*, which are located eccentrically or on each side of the true center of the disc. When a strain of tension is exerted on the rod *k* it draws the brake-shoe *B* against the wheel *C*, but at the same time it exerts a tension on the rod *l*, which is communicated to the shoe on the next wheel, and to as many more as have the brakes applied to them.

QUESTION 745. *For what service is the vacuum brake most used?*

Answer. It is now applied chiefly to the driving-wheels of

locomotives, but is also used on short trains which make frequent stops, as on the elevated railroads of New York.

CHAPTER XXXI.

DIFFERENT KINDS OF LOCOMOTIVES.

QUESTION 746. *Into what classes may locomotives be divided conveniently?*

Answer. 1. Locomotives for "switching," "shunting," or "drilling" service—that is, for transferring cars from one place to another at stations; 2, for freight traffic; 3, for ordinary passenger traffic; and 4, for metropolitan or suburban railroads, where a great many light trains are run.

QUESTION 747. *What kinds of locomotives are used in this country for switching cars at stations?*

Answer. Four and six-wheeled locomotives similar to those shown on page 88 of the current volume of the JOURNAL. Such engines are now usually made with separate tenders, but they are sometimes made so as to carry the water-tank and fuel in the locomotive itself, and are then called tank locomotives.

QUESTION 748. *Why are four and six-wheeled locomotives used for switching?*

Answer. Because in such service it is necessary to start trains often, many of which are very heavy, and therefore a great deal of adhesion is needed. For this reason the whole weight of the locomotive and, in the case of tank locomotives, that of the water and fuel, is placed on the driving-wheels. It is also necessary for such locomotives to run over curves of very short radius and into switches whose angle with the main track is very great; and therefore, in order that they may do this and remain on the track, their wheel-bases must be very short, and consequently the wheels are all placed near together and are usually between the smoke-box and fire-box.

QUESTION 749. *Why are such locomotives not suited for general traffic?*

Answer. Owing to the shortness of their wheel-bases they become very unsteady at high speeds, and acquire a pitching motion, similar to that of a horse-car when running rapidly over a rough track. This unsteadiness not only becomes very uncomfortable to the men who run the locomotive, but when it occurs there is danger of the engine running off the track. As nearly all switching is done at very slow speeds, it is not so objectionable for that service as it would be on the "open road"* at high speeds.

QUESTION 750. *How can such engines be made to run steadier?*

Answer. By putting a pair of truck-wheels under the front or rear end of the engine, as shown on page 89 of the current volume of the JOURNAL.

QUESTION 751. *What kinds of locomotives are used for passenger service?*

Answer. The greater part of the passenger service of this country is performed by locomotives like that selected for the illustrations of these articles, and represented in Plates III, IV, and V. Such locomotives have been called "American" locomotives, because they first originated in this country, and are now more generally used here than anywhere else. Perspective views of similar engines are also shown on page 234 of the current volume.

QUESTION 752. *How are such engines constructed?*

Answer. One pair of driving-wheels is usually placed behind the fire-box and one in front, and the front end of the engine is carried on a four-wheeled truck. In some cases the fire-box is extended back over the top of the rear axle. Usually the fire-box is placed between the frames, but they are sometimes put on top, in order that it can be made wider than is possible if it is placed between.

QUESTION 753. *What are the dimensions of such engines?*

Answer. The principal dimensions of the engines illustrated on page 234 are given below the engravings, but locomotives of this plan are built of much smaller and also of larger sizes than those represented by the engravings. In some cases they do not weigh more than 35 or 36,000 lbs., with cylinders from 8 to 12 in. in diameter. In other cases they weigh over 100,000 lbs., with cylinders 18 or 20 in. in diameter. The wheels vary from 4 to 6 ft. in diameter, but the most common sizes are $4\frac{1}{2}$ to $5\frac{1}{2}$ ft.

QUESTION 754. *What kinds of locomotives are used for freight service?*

Answer. Much of the freight service in this country is performed by "American" locomotives, similar to those described for passenger traffic. Usually engines used for freight service have smaller driving-wheels than those designed for passenger trains.

* The term "*open road*" is a literal translation from the German, for which there is no corresponding English term, and means the road between stations where trains run fast.

QUESTION 755. *When it is desirable to pull heavier loads than is possible with the adhesive weight that can be placed on four driving-wheels, what is done?*

Answer. One or more pairs of driving-wheels are added, as in the ten-wheeled and "Mogul" locomotives represented on page 235, and the "Consolidation" and twelve-wheeled engines on page 238, and the "Decapod" locomotive on page 335. The ten-wheeled locomotive is similar in construction to an ordinary "American" locomotive, excepting that it has another pair of driving-wheels in front of the main driving-wheels. It will be seen, however, that it is necessary to keep these close to the latter, because if they are brought further forward they will be too near the back truck-wheels. For this reason a truck consisting of a single pair of wheels is substituted in place of the four-wheeled truck and is placed in front of the cylinders, as represented in the engraving of the Mogul engine on page 235, and the front pair of driving-wheels can then be moved further forward, and they thus bear a larger proportion of the weight than they do if located as they are under the ten-wheeled engine. There is a similar difference between the construction of the twelve-wheeled and "Consolidation" engines shown on page 288.

QUESTION 756. *Under what circumstances are the different classes of freight locomotives which have been described employed?*

Answer. On comparatively level roads, or those having a light business, "American" locomotives are generally used for freight as well as passenger business. On lines which have moderately heavy grades or heavy traffic, ten-wheeled and Mogul engines are used; and where the grades and the traffic are both heavy, Consolidation or twelve-wheeled engines are employed. For excessively heavy mountain grades, Decapod locomotives are employed. For working some exceptionally heavy grades in India, twin engines, shown on page 333, have recently been built in England. These consist of two locomotives, each with three pairs of driving-wheels, coupled to a single double-ended tender between them, as shown in the engraving.

QUESTION 757. *What is meant by metropolitan and suburban railroads? What is the nature of their traffic?*

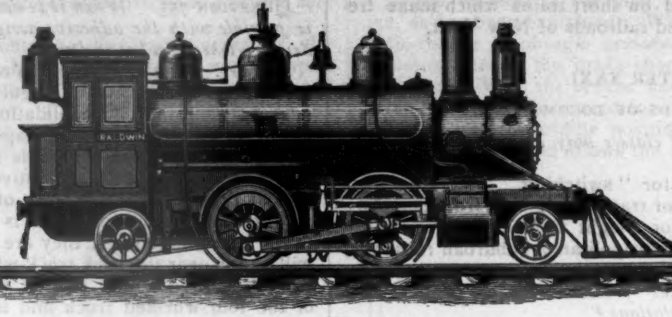
Answer. By metropolitan railroads are meant railroads in large cities. They may be divided into two classes: one for carrying freight cars from the outskirts of cities to the warehouses and stores at their business centers, and also from the terminus of one road to that of another. Metropolitan railroads of this kind are usually branches of lines which extend from the city. Locomotives for such traffic must have great tractive power, in order to pull heavy trains; and as the speed is usually slow, the wheels and the boiler capacity may be small. They must generally be capable of running through curves of very short radius; and as the traffic is usually carried through streets in close proximity to buildings, the locomotives should be as nearly as possible noiseless. The other class of metropolitan roads is for carrying passengers. The traffic of the latter is similar to that usually carried on horse railroads, and consists almost exclusively of passengers. Many light trains must be run at short intervals and at comparatively slow speeds, and therefore very light locomotives are required.

The traffic of suburban railroads consists chiefly of the transportation of passengers, who do business in a city, to the latter in the morning and to their homes in the evening. As the largest number of passengers must be carried during a few hours in the morning and evening, it is necessary to run very heavy trains at those times. As the passengers must be distributed at many stations which are near together, it is necessary to stop often; and in order that the average speed may be reasonably fast, the trains must run very rapidly between these stations. It is, therefore, essential to have heavy locomotives, with more than the usual proportion of adhesive weight, so that the trains can be started quickly without slipping the wheels. The main valves should also have a liberal amount of travel, so that steam will be admitted to and exhausted from the cylinders quickly. In some cases it is thought desirable to have locomotives which will run equally well either way, so that it will not be necessary to turn them around at each end of the "run."

QUESTION 758. *What kinds of locomotives are used on metropolitan railroads?*

Answer. For freight traffic ordinary switching locomotives, like that shown on page 88, are often employed. In some cases these have the water-tanks on the locomotives. It often happens though that such traffic must be conducted in the streets of a city, and that the noise, especially of the exhausting steam, is thus liable to frighten horses and disturb the occupants of the houses. It is, then, necessary either to condense the exhaust steam or render its escape noiseless, which is done by allowing it to escape into the water-tanks. Street locomotives which have a condenser similar to the surface condensers used on marine en-

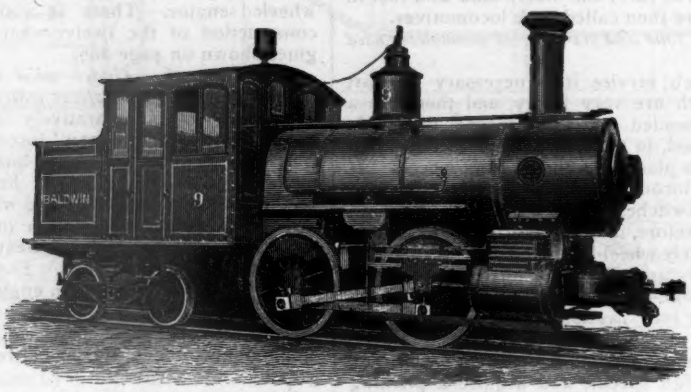
Fig. 434.



TANK LOCOMOTIVE FOR PASSENGER SERVICE.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

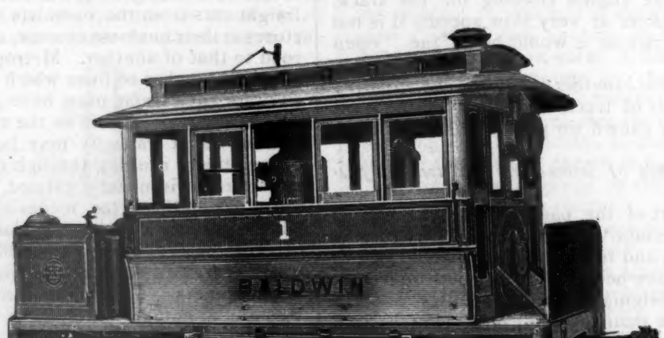
Fig. 435.



FORNEY LOCOMOTIVE FOR THE NEW YORK ELEVATED RAILROAD.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

Fig. 436.



LOCOMOTIVE FOR STREET RAILROADS.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

Fig. 437.

STEAM CAR FOR STREET RAILROADS.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

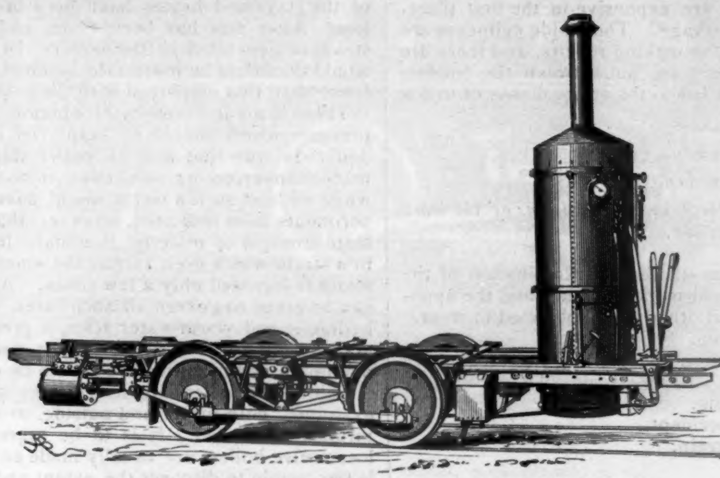
gines are used on the Hudson River Railroad in New York. The exhaust steam passes through these and then escapes into the tanks. The latter are long and narrow, so as to expose a great deal of surface to radiation, and in this way the water which becomes heated by the steam is cooled. The engines have four driving-wheels and vertical boilers. The cylinders are connected to a crank shaft with a pinion on it, which gears with another wheel of larger size on the driving-axle. In this way the speed is reduced, and great tractive power can be exerted. The whole of the engine is enclosed so as to hide the machinery, the sight of which is supposed to frighten horses. The engines were designed and patented by Mr. A. F. Smith, formerly Master Mechanic of that road.

by the truck. The load on the driving-wheels is therefore constant.

When larger engines are required and more water must be carried a four-wheeled truck is placed under the back end of the engine, as shown on page 332. This form of engine was first designed and patented by the Author, which must account for his name being coupled to it.

The late William S. Hudson designed and built a number of engines like that shown at the top of page 135. These each had a four-wheeled truck at the back end and a pony truck at the front. A similar engine, with three pairs of driving-wheels, and another with a six-wheeled truck at the back end and a four-wheeled truck in front are shown on page 134.

Fig. 438.



ENGINE FOR STEAM CAR FOR STREET RAILROADS.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

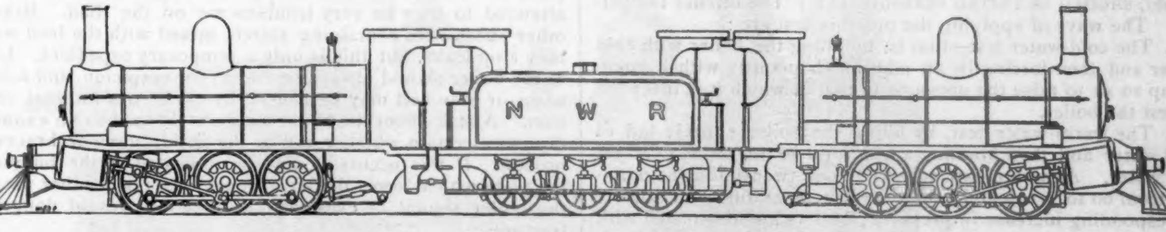
For roads in cities on which passengers almost exclusively are carried, an entirely different class of locomotives is needed. To suit passengers it is, of course, necessary to run a great many trains at very short intervals. When this is done the trains are necessarily very light, and therefore only light locomotives are needed. Fig. 435 represents one of the engines used on the New York Elevated Railroad. These run both ways, and through curves of only 90 ft. radius. Engines similar to that shown at the foot of page 89 are also used on this road.

QUESTION 759. *What kinds of locomotives are used for metropolitan and suburban railroads?*

QUESTION 760. *What kinds of locomotives are used on street railroads?*

Answer. Fig. 436 represents a locomotive which is used on street and suburban railroads. Its construction is similar to that of the engine shown at the foot of page 89, but it is enclosed with a large cab, so that the working parts are not exposed. This is done to prevent horses from being frightened.

Fig. 437 represents a steam car for street railroads, and fig. 438 shows the running gear and engine without the car body. In this passengers are carried in the same vehicle that contains the engine. As shown in fig. 438, the engine has a vertical boiler, and the working parts of the engines are placed below the floor of the car.



Answer. The ordinary American eight-wheeled locomotive is used, perhaps, more than any other kind; but a number of locomotives, like that represented at the top of page 89, have been built and are used for this traffic. These have one pair of driving-wheels in front of the main pair, and a Bissell truck in front of the cylinder. With this arrangement the driving-wheels bear a larger proportion of weight than they do if arranged on the ordinary American plan with a four-wheeled truck. Another plan is that shown at the foot of page 135. Such engines, it will be seen, have a Bissell truck at each end, and therefore they run equally well either way. The water and fuel is carried in a separate tender. In some cases the tanks of such engines are carried on the top and sides of the boiler, as shown in fig. 434. When they are obliged to run only a short distance, and a small supply of water is needed, this arrangement answers very well; but it is impossible to carry a large supply of water in this way without overloading the wheels of the locomotive, and at the same time increasing the evils of a varying load on the driving wheels.

To get over this difficulty, and at the same time dispense with a tender, the frames are extended behind the fire-box, as shown at the foot of page 89, and the water-tank is placed on top of this extension of the frames, and its weight is carried on a pony truck below the frames and behind the fire-box. With this arrangement the whole weight of the boiler and the machinery is kept on the driving-wheels, and the water and fuel is carried

QUESTION 761. *What is a compound locomotive?*

Answer. It is a locomotive in which the steam, after it has acted on the piston of one cylinder, escapes into another and larger cylinder, in which it acts on another piston, and thus expands more than it would if confined to one cylinder. Some engines of this kind have two cylinders, one large and one small one, or a high and a low-pressure cylinder. In other cases there are two high and one low-pressure cylinder, and in still others two high and two low pressure.

QUESTION 762. *What advantage is claimed for the compound system?*

Answer. A saving of about 15 per cent. of the fuel is claimed, owing to the greater degree of expansion of the steam. Thus far such engines have been used in this country only in an experimental way, but they are now (1889) extensively used in Europe.

QUESTION 763. *What is the difference between inside and outside cylinder engines?*

Answer. In this country it is the universal practice to put the cylinders of locomotives outside of the wheels and frames, and connect the pistons to crank-pins on the outside of the wheels. In Europe, especially in England, it is more common to put the cylinders between the frames and wheels, and connect the pistons to cranks on the main driving-axle.

QUESTION 764. *What are the relative advantages and disadvantages of these methods of construction?*

Answer. It is claimed that engines with inside cylinders run steadier than those with the cylinders outside, owing to the greater leverage which the pistons of the outside cylinders exert, owing to their greater distance from the center line of the engine. This is undoubtedly true; but if locomotives are made with a long wheel-base, as they may be if one or two trucks are used, this leverage has very little influence on the steadiness of running of the engine. It is also claimed that when inside cylinders are used they are better protected from radiation and loss of heat, as they can be placed inside of the smoke-box. On the other hand, the great objection to inside cylinders is the crank-axles, which are expensive in the first place, and are subject to frequent breakage. The inside cylinders are also more or less inaccessible for making repairs, and there are limitations to their size, if they are put between the frames. Experience in this country has led to the entire disuse of inside cylinders on locomotives.

CHAPTER XXXII.

INSPECTION OF LOCOMOTIVES.

QUESTION 765. *What are the principal divisions of the work of operating or running a locomotive?*

Answer. They are:

1. Inspection and lubrication—that is, an examination of the parts to see that they are in good working order, and the application of oil to the journals and other parts subjected to wear.
2. Getting up steam and firing.
3. Setting the engine in motion and starting the locomotive and train.
4. Management while running.
5. Management in case of accident.
6. Stopping the engine and train.
7. Laying up.
8. Cleaning the engine.

QUESTION 766. *When should a locomotive be inspected?*

Answer. It should be inspected after it has finished its run, and when there is no fire in the fire-box and when the engine is cold, so that the grates, smoke-box, chimney, and other parts can be examined. The object of this inspection is to see whether any repairs are needed before the next run. The engine should again be inspected before making another run, to see whether every part is in good condition, and that the repairs, if any were needed, have been properly made.

QUESTION 767. *When the locomotive is first inspected, what should be especially observed about the boiler?*

Answer. In the first place, all new boilers should be tested by pressure before being used, and ALL boilers, whether new or old, SHOULD BE TESTED PERIODICALLY. The oftener the better. The ways of applying the pressure test are:

1. The cold-water test—that is, by filling the boiler with cold water and then forcing in an additional quantity with a force-pump so as to raise the pressure to that at which it is intended to test the boiler.

2. The warm-water test, by filling the boiler entirely full of cold water and then kindling a fire in the grate, so as to warm this water. As water expands about one twenty-fourth in rising from 60 to 212 degrees, the rise in temperature will cause a corresponding increase in pressure; boilers are also tested with warm water by forcing it into them with an injector, which receives a supply of steam from another boiler.

3. By steam pressure.

If the latter method were not so commonly used, it would seem the height of madness to test a boiler—which is neither more nor less than an attempt to explode it—in the shop where it is built or repaired, and where the results of an explosion would be more disastrous and fatal than anywhere else, in order to see whether it will explode when put into service on the line of the road. The danger of explosion is also increased at such times by hammering and caulking at leaky rivets and joints.* It would seem, therefore, very much more rational to test boilers first by hydraulic pressure. For a first test this is preferable, because cold water will leak through crevices which would be tight when the boiler is heated, so that leaks can be more surely detected with cold than with warm or hot water. It is, however, doubtless true that boilers are often strained much more by the unequal expansion of the different parts than by the actual pressure. It is therefore thought that after the hydraulic test has been applied the second or warm-water test should be used. This can be easily done, as the boiler must be filled full of water for the first test. When the boiler is subjected to the test pressure, it should be carefully examined to see whether any indications of weakness are revealed. Any material change of form or any very irregular change of pressure is indicative of weakness. The flat stayed surfaces should be carefully examined by applying a straight edge to them before and after they are subjected to pressure, to see whether they change their form materially. One of the greatest dangers and most common accidents to locomotive boilers, as has been pointed out in a previous chapter, is the breaking of stay-bolts, to detect which, a locomotive runner and master mechanic should exercise constant vigilance. While the pressure is on, the outside surface of the boiler should be thoroughly examined with slight blows of a hammer, which will often reveal a flaw in the metal or a defect in workmanship. After the hydraulic and warm-water tests have been applied, the boiler should be emptied, and the inside examined carefully to see whether any of the stays and braces have been broken or displaced by the test. After this has been done, and not until then, should steam be generated in the boiler. In making the latter test it would doubtless be more safe to employ a pressure somewhat lower than that employed with the cold and warm water.

There is great diversity of opinion regarding the maximum pressure which should be employed in testing boilers. It is doubtless true that a weak boiler might be injured and thus made dangerous by subjecting it to a very severe pressure, while without such a test it would have been safe. Recent experiments have indicated, however, that in most cases the ultimate strength of material is actually increased by subjecting it to a strain which even *exceeds* the elastic limit, provided such a strain is imposed only a few times. Although no absolute rule can be given to govern all such cases, it is thought that for the hydraulic and warm-water tests, a pressure about 50 per cent. greater and for the steam test 25 per cent. greater than the maximum working pressure should be employed.

Before old boilers are tested, they should be very carefully examined, both inside and outside, to see whether they are injuriously corroded. It is to be regretted that the insides of locomotive boilers are usually made so difficult of access that it is impossible to discover the extent and the effects of corrosion without the most careful examination. This is not possible without getting inside of the boiler. Whenever this can be done, a prudent locomotive runner should use the opportunity of inspecting the boiler of his engine himself, and not depend upon the boiler-makers who are employed for that purpose. He should remember that it is his life and not theirs which is exposed to danger by any weakness or defect in the construction of the boiler of the locomotive which he runs.

Before starting the fire in a locomotive, the fire-box should be carefully examined to see if there are any indications of leaks, which will often reveal cracked plates, defective stay-bolts or flues. If the latter simply leak at the joints, they can generally be made tight by caulking or by the use of a tube expander. This is easily done when the engine is cold, but if not attended to may be very troublesome on the road. Bran or other substances containing starch, mixed with the feed water, may stop leaks, but this is only a temporary expedient. Leaks of the boiler should always be causes for suspicion, and a leaky seam or stay-bolt may be caused by dangerous internal corrosion. A leak about the boiler head should lead to an examination, to ascertain whether any of the inside stays or braces are broken. If this occurs it may be indicated by the bulging of the plate which forms the boiler head. Leaks at other parts of the boiler should be examined, as they may reveal dangerous fractures.

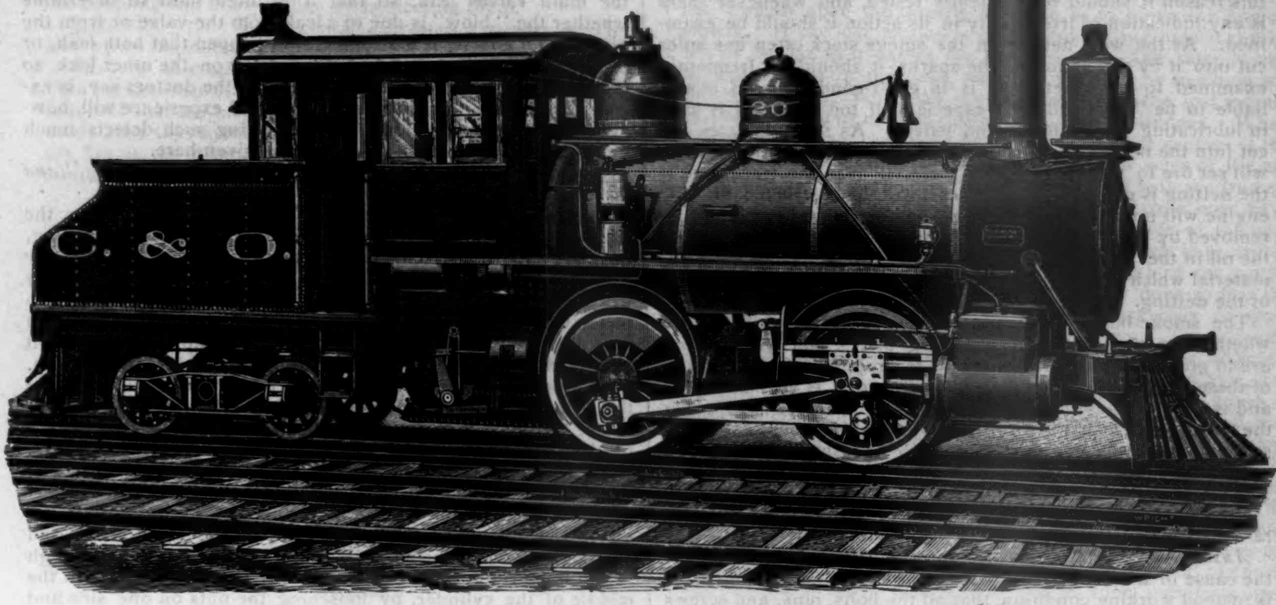
It is of the utmost importance, both for safety and for economy of working, that boilers should be kept clean—that is, free from mud and incrustation. In some sections of the country, especially in the Western States, this is the greatest evil against which locomotive runners and those having the care of locomotives must contend. The cures which have been proposed are numberless, but that which is now chiefly relied upon is, first, the use of the best water that can be procured, and second, frequent and thorough washing out of the boiler.

QUESTION 768. *What sort of examination should be given to the boiler attachments?*

Answer. It should be observed whether the grate-bars or drop-doors of the grate are properly fastened, whether any of the grate-bars are broken, and whether the ashes have been cleaned out of the ash-pan, and also whether the fire is clean—that is, whether the grates are free from cinders or clinkers. The height of water in the boiler should be observed by testing it with the gauge-cocks and by noticing it in the glass gauge, if one of these is used. It is also well to blow out the sediment and mud from the glass gauge before starting, and to see that the valves which admit steam and water to the glass are open. They should, however, be opened only a very short distance, so that only a small quantity of steam or hot water will escape in case the glass tube should be broken. The injector, if one is used, should be tested to see that it is in working order, and as soon as the engine starts out of the engine house both of the

* Wilson on Boiler Construction.

CATECHISM OF THE LOCOMOTIVE.



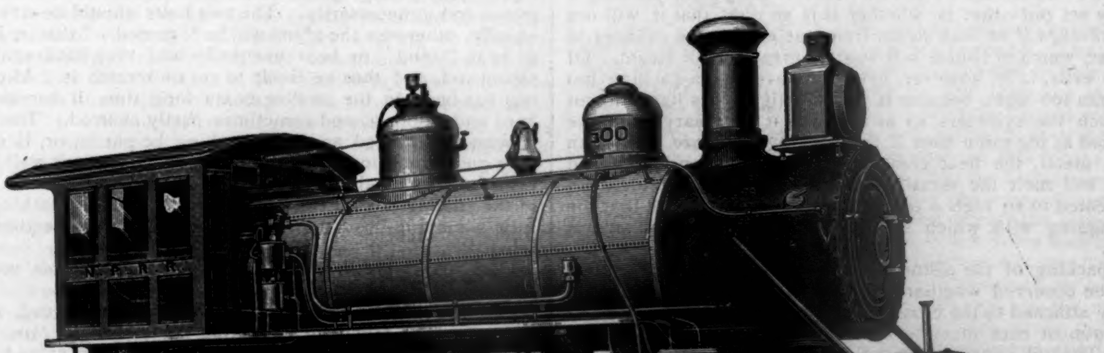
FORNEY LOCOMOTIVE FOR SUBURBAN TRAFFIC.

BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.

Total weight in working order	110,000 lbs.
Total weight on driving-wheels	75,000 "
Diameter of driving-wheels	4 ft. 9 in.
Diameter of truck-wheels	2 " 6 "
Diameter of main driving-axle journal.	7½ "
Distance from center of front to center of back driving-wheels	7 ft. 6 "
Total wheel-base of engine	23 " 7 "
Diameter of cylinders	17 "
Stroke of cylinders	24 "
Outside diameter of smallest boiler-ring.	54 "

Length of fire-box, inside	5 ft. 0⅛ in.
Width of fire-box, inside	2 " 10⅝ "
Depth of fire-box, crown-sheet to top of grate	5 " 6 "
Number of tubes	187
Outside diameter of tubes	2 in.
Length of tubes	11 ft. 6 "
Grate surface	14.3 sq. ft.
Heating surface, fire-box	127.8 " "
Heating surface, tubes	1,116.9 sq. ft.
Heating surface, total	1,244.7 " "

Exhaust nozzles	Single.
Size of steam-ports	16×1¼ in.
Size of exhaust-ports	16×2½ "
Throw of eccentrics	5½ "
Greatest travel of valve	5⅜ "
Outside lap of valve	0⅝ "
Smallest inside diameter of chimney	1 ft. 6 "
Height, top of rail to top of chimney	14 " 4 "
Height, top of rail to center of boiler	6 " 8 "
Water capacity of tank	1,500 gals.
Coal capacity	6,000 lbs.



DECAPOD LOCOMOTIVE.

BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

Total weight in working order	148,000 lbs.
Total weight on driving-wheels	123,000 "
Diameter of driving-wheels	3 ft. 9 in.
Diameter of truck-wheels	2 " 6 "
Diameter of main driving-axle journal.	8 "
Length of main driving-axle journal	9 "
Distance from center of front to center of back driving-wheels	17 ft. 0 "
Total wheel-base of engine	24 " 4 "
Total wheel-base of engine and tender.	49 " 2 "
Diameter of cylinders	22 "
Stroke of cylinders	26 "

Outside diameter of smallest boiler ring	5 ft. 8 in.
Length of fire-box, inside	10 " 1¼ "
Width of fire-box, inside	3 " 6⅝ "
Depth of fire-box, crown-sheet to top of grate	4 " 6½ "
Number of tubes	270
Outside diameter of tubes	2¼ in.
Length of tubes	13 ft. 6 "
Grate surface	36 sq. ft.
Heating surface, fire-box	162 " "
Heating surface, tubes	2,148 " "
Heating surface, total	2,310 " "

Exhaust nozzles	Double.
Size of steam-ports	16×1¼ in.
Size of exhaust-ports	16×3 "
Throw of eccentrics	5 "
Greatest travel of valve	5⅜ "
Outside lap of valve	0⅝ "
Smallest inside diameter of chimney	1 ft. 8 "
Height, top of rail to top of chimney	14 " 6 "
Height, top of rail to center of boiler	7 " 3⅛ "
Water capacity of tender tank	3,600 gals.

pumps—if there are any—should also be tested, in order to see whether they are in good working condition. The safety-valves should be raised, so as to be sure that they are not rusted or otherwise fastened to their seats. There is no part of a locomotive more liable to disorder than the steam gauge. For this reason it should be frequently tested, and whenever there is any indication of irregularity in its action it should be examined. As the wire netting on the smoke stack often has holes cut into it by the action of the sparks, it should be frequently examined to see whether it is in good condition. It is also liable to be "gummed up," especially if too much oil is used in lubricating the cylinders and valves. As soon as holes are cut into the netting there is danger that the sparks which escape will set fire to the combustible material near the track, and if the netting is gummed up the draft will be obstructed and the engine will not make steam. The gummy matter can often be removed by building a fire on top of the netting. In this way the oil in the gummy matter is burned up, which leaves a dry material which can then, at least to some extent, be beaten out of the netting.

The smoke-box door should be opened occasionally to see whether the petticoat-pipe, deflecting plates, and wire netting are in good condition and properly secured, as a failure of any of these parts when the engine is on the road is very annoying and is liable to cause much delay. If there is any suspicion that the steam pipes leak, the throttle-valve should be opened slightly, so as to give the engine steam while the smoke-box door is open. The leak will then be indicated by the escaping steam. The smoke-box should be kept clear of ashes and cinders.

QUESTION 769. *What should be noticed in connection with the throttle-valve?*

Answer. As a failure of the throttle valve to work may be the cause of a most serious accident, it should be certain that it is in good working condition, that all the bolts, pins, and screws and other accessories are in good working order. It should also be known whether the throttle-valve is steam-tight. This can be learned by observing whether steam escapes from the exhaust-pipes or cylinder-cocks when the latter are open, the reverse lever in full gear, and the throttle-valve closed. If the throttle-valve leaks, enough steam may accumulate in the cylinder, when there is no one on the engine, to start it, and in this way cause a serious accident. The throttle lever should always be fastened with a set-screw or latch of some kind when the engine is standing still.

QUESTION 770. *In inspecting the cylinders, pistons, guides, and connecting-rods, to what points should the attention be directed?*

Answer. It should be known whether the piston packing is properly set out—that is, whether it is so tight that it will not "*blow through*," or leak steam from one end of the cylinder to the other, which of course will waste a great deal of steam. Of the two evils, it is, however, better to have piston-packing too loose than too tight, because if it is too tight, it is liable to cut or scratch the cylinders so as to make it necessary to rebore them, and at the same time if the packing-rings are lined with Babbitt metal, the heat created by the intense pressure and friction will melt the metal. In some cases the cylinders become heated to so high a temperature from this cause that the wood-lagging with which they are covered on the outside is burned.

The packing of the piston-rods should be steam-tight, and it should be observed whether the rod and the pump-plunger are securely attached to the cross-head.

The utmost care must be exercised to keep the guides well oiled. The oil cups on the guide-rods or cross-heads, when they are placed on the latter, must be kept clean, so that the oil will flow freely, and yet not too rapidly, on the surfaces exposed to friction. The same thing is true of the oil-cups on the connecting-rods. Attention should be given to the brass bearings of the connecting-rods to see that they are not so loose as to thump, nor keyed so tight on the crank as to be liable to heat. The latter can be easily known by moving the stub-end lengthwise of the journal. They should never be so tight that they cannot be thus moved with the hand. Especial attention should be given to seeing that all the bolts and nuts on the connecting-rods are tight. There are no parts of a locomotive which require more careful attention in order to keep them lubricated, and thus prevent them from heating and being "cut," than the bearings on the crank-pins and the slides of the cross-head. Examination should be made to see that neither the piston-rods, pump-plungers, guides, connecting-rods, nor crank-pins are bent or sprung.

QUESTION 771. *How can it be known whether the piston-packing is too loose or "blows through?"*

Answer. It can usually be noticed in the sound of the exhaust, which can be heard very distinctly on the foot-board when the furnace door is opened. If the packing is not tight, it produces a peculiar wheezing sound between and after each discharge of steam. If the packing leaks, it will also be indicated by the escape of steam from *both* the cylinder-cocks, if they are open, just after the crank passes the dead point. This will usually show in which of the cylinders the packing is too loose. The same thing will occur, however, if either or both of the main valves leak, so that it is often hard to determine whether the "blow" is due to a leak from the valve or from the piston. Of course, it may sometimes happen that both leak, or that the piston on one side and the valve on the other leak, so that often the diagnosis of the disease, as the doctors say, is extremely difficult. Careful observation and experience will, however, aid a locomotive runner in detecting such defects much more than any directions which can be given here.

QUESTION 772. *What is meant by "setting out packing," and how should it be done?*

Answer. "Setting out packing" is simply expanding the rings when they get too loose. With ordinary spring packing, figs. 182 and 183, which is now generally used, this is done by screwing up the nuts *b*, *b*, *b*, which, as was explained in answer to Question 309, compresses the springs *a*, *a*, *a*, and thus expands the rings *A*, *A*. In doing this, as already stated, great care must be exercised not to screw the nuts up too hard, and it is always better to have the packing too loose than too tight. Care must also be taken to keep the piston-rod in the center of the cylinder, otherwise there will be undue pressure and wear on the stuffing-box. After the nuts are screwed up, the position of the piston-head should be tested with a pair of callipers. This is done by placing one leg of the callipers against the side of the cylinder, and setting them so that the other leg will just touch the edge of the projection *C*, fig. 183, or the end of the piston-rod. Then by placing the callipers above and below, and on each side of the piston, it will appear whether it is too high or too low or too near either side. If the piston is not in the middle of the cylinder, by loosening the nuts on one side and tightening them on the other it can be moved to a central position. Ordinarily this work is intrusted to persons who are employed for the purpose. A young locomotive runner, fireman, or mechanic will, however, always do well to familiarize himself with such duties, and, if possible, do it himself, under the direction of those who are skilled in that kind of work.

QUESTION 773. *If the stuffing-box of the piston-rod leaks, what should be done?*

Answer. If it is packed with fibrous packing and it is in good condition, it can usually be made tight by simply screwing up the nuts on the gland. In doing this, they should not be screwed up more than is necessary to make the packing steam-tight. Any greater pressure only increases the friction on the piston-rod unnecessarily. The two bolts should be screwed up equally, otherwise the gland will be "canted—" that is, inclined so as to "bind" or bear unequally and very hard against the piston-rod, and thus be liable to cut or scratch it. After packing has been in the stuffing-box a long time, it becomes very hard and compact, and sometimes partly charred. Then either it must be removed and new packing be put in, or, if in tolerably good condition, it can often be made to work well by simply reversing it—that is, by putting that which was at the bottom of the stuffing-box on top and *vice versa.* Before packing is put into a stuffing-box, the former should always be thoroughly oiled.

QUESTION 774. *When the slides of the cross-heads wear, how is the lost motion taken up?*

Answer. When there are gibs on the cross-head, the lost motion can be taken up by putting "*liners*" or "*shims*"—that is, thin pieces of metal, between them and the cross-head, so that they will fill up the space between the guide-bars. When there are no gibs, the guide-bars must be taken down, and the blocks between them at each end must be reduced in thickness so as to bring the bars nearer together. In doing this, great care must be taken that the guides are accurately "in line" with the center line or axis of the cylinder. This work should never be intrusted to any excepting skilled workmen, from whom those who are inexperienced should seek instruction.

QUESTION 775. *When the brass bearings of the connecting-rods become too loose on their journals, what should be done?*

Answer. They must be taken down, and the two surfaces in contact must be filed away so as to bring them closer together. In doing this they must be filed square with the other surfaces, otherwise they will not bear equally on the journals when they are keyed up. Before attaching them permanently to the rods, they should be keyed on the journal in the strap alone, so that it can be known by trial whether they move freely and yet are tight enough to prevent thumping on the journal. When they are attached to the rod, it is very important, especially with coupling or parallel-rods, that the correct length from center to center of the bearings be maintained. It is much better to leave coupling-rods loose on their journals, because, if the bearings are keyed up tight, the rods are sure to throw an

enormous strain on the crank-pins, as the distance between the centers of the axles is not always absolutely the same, owing to the rise and fall of the axle-boxes in the jaws. It is therefore always best to have a little play in the coupling-rods, and it is safe to say that much more mischief is done by meddling with the coupling-rod brasses than by neglecting them.

QUESTION 776. *What should a locomotive runner observe in making an inspection of his locomotive?*

Answer. A good locomotive runner will always give ample time for the inspection of his engine before starting out. It is assumed that the inspection which has been described has been made after the engine has completed a trip, and when there is no fire in the fire-box. Before starting a careful locomotive runner should begin at the front of his engine and see that the

PILOT

and all its fastenings are in good condition. He should be especially alert in inspecting this, as well as all other parts of the locomotive, to see that

BOLTS AND NUTS

have not been lost, and are screwed up tight, and that the

KEYS

are all right. If any part of his run is made after dark he should examine the

HEAD-LIGHT,

to see that it has been properly filled and trimmed and is in good condition, and also that the

SAND-BOX

has been filled. All the

WHEELS

of the engine and tender should be carefully examined, to see that they are sound. A fracture in a driving-wheel is usually apparent if the wheel is carefully examined. The condition of ordinary cast-iron tender and truck-wheels is revealed on striking them with a hammer, when if they are sound they will give out a peculiar clear ring; whereas if they are fractured, the sound produced by the blow of the hammer may be dead, like that of a cracked bell.

An inspector should not rely entirely on this test, as broken wheels will sometimes give a clear ring. He should examine them carefully for cracks or other fractures, and should see that the flanges are not broken, as this may occur and not be revealed by the sound produced by a blow from a hammer. If any of the flanges of the wheels are unduly worn the fact should be reported to the proper person. The wearing of flanges is due to a variety of causes which are sometimes difficult to discover, such as the difference in the diameters of the wheels or the hardness of the tires in the same axle; axles not parallel or the truck "out of square," center-plate or pin not in the center of truck, bent axles or malformation of rails are some of the causes which produce sharp flanges. The

STEEL TIRES

of both the driving and the truck-wheels should be examined for flaws and broken flanges, and to see whether they have worked loose on the wheel-centers. Moisture and dirt issuing from between the tire and wheel indicates that the former is becoming loose, which is more liable to occur when the tires are worn thin than before. The

AXLES

too should be examined to see that the wheels have not worked loose on the wheel-seat. When this occurs it often becomes apparent by the oil from the axle-boxes working through between the hubs of the wheel and the axle. This can be observed on the outside of the wheels when the bearings are inside, and inside the wheels when the bearing is outside. The

SPRINGS

should be examined, to see that they are in good condition, and the oil holes in the boxes must be kept clear, so that the oil can reach the bearings. The

TENDER AND ENGINE TRUCK-BOXES

are kept oiled by packing them with cotton or woolen waste saturated with oil. This should be taken out occasionally and renewed and the boxes cleaned. The working of the

DRIVING BOXES

up and down the jaws will in time wear them so that there will be some lost motion in the jaws. This will be indicated by a thump when the cranks pass the dead point. A similar thump will, however, be produced by lost motion in the boxes of the main connecting-rod, so that it is difficult to determine, without special examination, the cause which produces the concussion. It is therefore best when an engine works with a thump at each revolution for the runner to stand by the side of it where he can touch the connecting-rods and driving-wheels, and then have the fireman open the throttle-valve, so as to move the engine slowly. If the lost motion is in the connecting-rods it can be felt by the jar as it passes the dead points. The same is true of lost motion in the jaws, which can be felt by touching the driving-wheels. When the jaws become worn the lost motion can be taken up by moving up one or both of the wedges. When this is done, great care must be taken to keep the centers of the driving-axles the same distance apart on both sides of the engine, and also to keep their center lines square with the frames. In the best designed locomotives the driving-boxes now have only one wedge, which is usually on the back side of the box, as shown in fig. 286. The frame in front of the box is protected by a straight shoe or by a wedge the full length of the jaw so that it cannot be moved up or down. This is done so that the position of the box cannot be changed by carelessly or ignorantly moving one wedge up and the other down. There should always be center-punch marks placed on the frames or guide-yokes on each side of the engine in front of the main axle, and at equal distances from its centers, so that when the boxes or jaws become worn the position of the axle can be adjusted with a tram from these marks. Of course, if the main axle is square, it is easy to adjust the trailing axle from it with a tram. If the axles are not square with the frames and parallel with each other, the engine will run toward one side or the other of the track, according to the inclination of the axles. It sometimes happens that the bolts which hold up the wedges in the jaws are broken. When this occurs the wedge drops down, and of course the box has so much lost motion that it soon manifests itself in the working of the engine. These bolts, and also those which hold up the clamps on the frames at the bottom of the jaws, should be examined when the engine is inspected, so as to be sure they are in good condition.

The engine and tender should occasionally be lifted up from the

CENTER-PLATES

of the trucks, and the plates should be lubricated with tallow. It often happens that these become dry, so that they are difficult to turn when the weight rests on them, and therefore they will not adjust themselves easily to the curves of the track.

QUESTION 777. *What part of the valve-gear should receive attention when the engine is inspected?*

Answer. *All* the bolts, nuts, and keys should be carefully examined to see that they are properly fastened. The bolts and nuts in the eccentric straps are especially liable to become loose, and as they are between the wheels, and therefore not easy of access, are often neglected. The oil-holes should all be seen to be clear, otherwise it will be impossible to keep the journals well oiled. The eccentric straps and the link blocks are very liable to be imperfectly oiled, and when the former become dry and cut, they throw a great strain on the eccentric-rods, which is liable to break them. When this occurs the strap and the portion of the rod which is attached to it revolve with the eccentric, and frequently a hole is thus knocked into the front of the fire-box, which disables the engine. The valve gear is, with the exception, perhaps, of the pumps and injector, the most delicate part of the locomotive, and more liable to get out of order than any other, and should therefore be watched with the greatest care.

QUESTION 778. *How can it be known whether the main valves of a locomotive are tight?*

Answer. As already indicated, the symptoms which manifest themselves when a valve leaks are very similar to those which appear when the piston packing leaks. If the valve is moved to its middle position and steam is admitted into the steam-chest, and it then escapes from both cylinder-cocks, it is apparent that the valve is not tight. But the valve faces of locomotives usually wear concave, because the valves are worked most about half-stroke, so that they will often be tight when in the center of the face, but will leak at the ends of the full stroke. This will become apparent by the peculiar wheezing sound, already referred to, when the engine is at work. As has been explained, it is, however, often very difficult to determine whether this sound is due to a leak at the pistons or the valves. If the packing of the valve-stem leaks, it can be remedied in the manner described for making that of the piston-rod tight.

QUESTION 779. *What other parts of a locomotive should be examined before starting?*

Answer. It should be certain that the brakes on the tender are in good working condition—that is, that the bolts, nuts, and keys are all secure, the levers, rods, and chains properly connected, and the shoes fastened and not too much worn. If

either an atmospheric or vacuum brake is used, it should be tested before starting, as was fully explained in Chapter XXVI.

The inside of the water-tank should also be examined occasionally, to see whether it is clean, and if not it should be thoroughly washed out. If the tank is new or has had any repairs done to it, the inside should be carefully examined to see whether any waste rags or other objects have been left in it, as these might obstruct the strainers over the water-supply pipes. The strainers should be examined occasionally to see whether they are clear. The man-hole of the tank should always be covered, excepting while taking water, so as to exclude cinders and coal, which are liable to obstruct the pump valves. It is hardly necessary to say that it must always be certain before starting that there is enough water in the tank to feed the boiler until the next point is reached at which a supply can be obtained. The sand-box must also be filled, the bell rope in good condition, and if running at night the reflector of the head-light must be polished and the lamp supplied with oil and the wick trimmed so as to burn brilliantly. The locomotive runner must also see that the proper signals are displayed in front of his engine.

QUESTION 780. *What tools, etc., should every locomotive runner on the road carry?*

Answer. A coal shovel, coal pick, long-handled hoe* and poker, a pair of jacks—either screw or hydraulic, chains, rope and twine to be used in case of accident, a heavy pinch-bar for moving the engine, a small crow-bar, oil-cans with short and long spouts and another smaller one with spring bottom, a steel and a copper hammer, a cold and a cape chisel, a hand-saw, axe and hatchet, one large and one small monkey-wrench and a full assortment of solid wrenches for the bolts and nuts of the engine, cast-iron plugs for plugging tubes, with a bar for inserting them, two sheet-iron pails or buckets, different colored lanterns and flags, according to the colors used for signals on the line, and a box with a half dozen torpedoes.

QUESTION 781. *What duplicate parts should be carried with the engine?*

Answer. Keys, bolts, and nuts for connecting-rods, split-keys, wedge bolts, bolts for oil-cellars of driving and truck-boxes, driving and truck spring-hangers, wooden blocks for fastening guides in case of accident, blocks for driving-boxes and links, a half dozen ⅞-in. bolts, from six inches to two feet long, to be used in case of accident, two extra water-gauge glasses, two glass head-light chimneys.

QUESTION 782. *What should be observed in lubricating a locomotive or any other machinery?*

Answer. The most important thing to observe is that the oil reaches the surface to be lubricated. It is of much greater importance that the lubricant should reach the right place than that a large quantity should be used. A few drops carefully introduced on a journal will do much more good than a large quantity poured on the part carelessly. For this reason all oil-cups and oil-holes should be kept clean so as to form a free passage for the oil. It should also be remembered that no automatic oil-cup will work satisfactorily a great while unless it receives the attention which all of them require.

The following directions have been given by the manufacturers for the care of the sight feed lubricators, illustrated and described in Chapter XXIX. :

DIRECTIONS FOR USING THE NATHAN SIGHT-FEED LUBRICATOR.

"Fill the cup with clean, strained oil through the filling plug *A*, then open the water-valve *D*.

"To start: Open the steam-valve *B*, wait until the sight-feed glasses have filled with condensed water, then regulate the feed by the valves *C C*. To stop: Close the valves *C C*.

"To renew the supply of oil: Close the valves *C* and *D*, and draw off the water at the waste-cock *E*; then fill the cup and start again as before. always opening the valve *D* first.

"The valves *F F* must be always kept open, except when one of the glasses breaks. In such case close the valves *F D* and *B*, to shut off the cup, and use the auxiliary oilers *O O* as common cab oilers.

"The valve *D* must be closed or opened in advance of the valve *B*, whenever this latter is closed or opened.

"Once in two weeks at least blow out the cup with steam, opening the valves wide, with the exception of the filling plug *A*, which should remain closed."

In inspecting a locomotive, it should be observed whether the oil-cups are screwed down tight to the part to which they are attached. They are liable to work loose and be lost, or by getting between some of the working parts, to cause a breakdown.

QUESTION 783. *What precaution should be taken if any repairs have been done to the engine?*

Answer. The parts which have been repaired should be examined carefully to see that they have been properly done, and if they require lubrication, it should receive especial attention, as new parts are always liable to heat or cut.

QUESTION 784. *In the examination, care of, and repairs to injectors what precautions should be observed?*

Answer. 1. The pipe connections should be kept perfectly tight to prevent air leaks.

2. The steam-valves should be kept tight to prevent escaping steam from heating the suction-pipe, which interferes with the formation of a vacuum and prevents the instrument from lifting the water.

3. The packing of the different spindles and valve-stems to be kept in good condition, so that they will be steam or air-tight.

4. The nozzles of the injector must be taken out and thoroughly cleaned more or less often—according to the character of the water used—so as to keep them as far as possible free from incrustation. Mineral oil drawn with the water, when the injector is at work, will have an excellent effect in keeping it free from scale. Some injectors are arranged to receive an oil-cup for this purpose.

5. The boiler check-valves must be kept tight and free from dirt and incrustation, to prevent the back-flow of hot water and the sticking of the valves.

QUESTION 785. *If a lifting injector is tested and does not lift the water properly, to what causes may it be due?*

Answer. It may be due:

1. To a leak in the steam-valve, and the consequent heating of the suction-pipe to such a degree as to prevent the formation of sufficient vacuum in that pipe. This defect can be remedied only by grinding the steam-valves, so as to make them tight. Such a leak will be indicated by an escape of steam from the overflow when the steam-valves are closed.

2. To a leak in the suction-pipe or its connection, in which case the air drawn in by applying the lifting jet will prevent the formation of the vacuum. Such a leak can be detected by closing the heater-cock and opening the main steam-valve only—if there is a separate lifting jet—or, with a single lever instrument, by opening both steam-valves at once. The steam blowing back to the tank will then escape through the leak, if there is one. The trouble will usually be remedied by tightening up the suction pipe connections.

3. To a leak in the boiler check-valves and the consequent heating of the suction-pipe by the hot water from the boiler flowing back through the injector. Grinding the check-valve will remedy this.

QUESTION 786. *If the injector lifts the water, but does not take it up and throw it out through the overflow, or the stream flowing into the boiler breaks, to what causes may it be due?*

Answer. 1. To a slight leak in the suction-pipe, not sufficient to prevent a short lift, but enough so that the air drawn in disturbs the current in the nozzles. Such a leak can be detected and remedied as explained in answer to the previous question.

2. To obstructions in the suction-pipe, floating matter, bits of wood, hemp, leaves, obstructions in the strainer, or not sufficiently large strainer to admit the proper supply of water. If the strainer is obstructed it must be taken out and cleaned. The present strainers in general use, consisting of a perforated cone inside of the suction-pipe, are a frequent cause of trouble in the working of injectors. They are usually not large enough and difficult of access for cleaning. The suction-pipe itself can be cleaned by blowing steam through it with the heater cock closed.

3. To boiler check-valves sticking fast, on account of corrosive incrustation, or dirt in the valve-chamber, which prevents the free action of the valves. The remedy is to open the valve-chamber, and thoroughly clean the valve, its seat, and guides.

4. To leaky heater-cock check, which will be indicated by a sputtering sound, which is again caused by the air taken in through the overflow. Grinding the check will remedy it.

* These are of course not needed on wood-burning engines.

Manufactures.

The Griggs Electric Air Signal.

THE accompanying illustrations show a system of communication between train and engine intended to replace the bell-cord. This device is the invention of Mr. G. M. Griggs, and is made by the Griggs Electric Air Signal Company, of Wilmington, Del.; it has been submitted to a very full trial on the Wilmington & Northern Railroad, with very satisfactory results.

The system is operated by opening and closing a small plunger-valve by an improved electro-magnet, the valve sup-

plying air for the blowing of a miniature whistle, the time and duration of the blast being governed by the conductor at will.

The magnet valve and box are shown in fig. 1 sufficiently to dispense almost with any explanation. The dotted lines on the valve exterior show the air passages, valve and seat. The magnet has a peculiar feature, as shown, which is new. Instead of an ordinary flush face, the core is made with lopping ears rising at a slight angle, the purpose of which is to decrease the traverse of the magnetic field, and bring the armature within very close play of the iron, at the same time giving all the needed travel to open the valve at the smaller lever end. The advantage in this is to greatly increase the efficiency of the system, as the magnetic field decreases as the square of the distance increases between armature and magnet core. The wires at the bottom of the box are the terminals of the magnet.

The coupling, fig 2, is of the plunger type, made of hard rubber and spring brass; it is in shape to meet the very rigorous requirements made of it, as it is swung underneath the platform and subjected to flying dust, dirt, and moisture. The plungers are made pene-headed, and operated as shown in the section. By reason of the pene-head expanding in the interior of the female end, it is kept constantly bright by the compression in

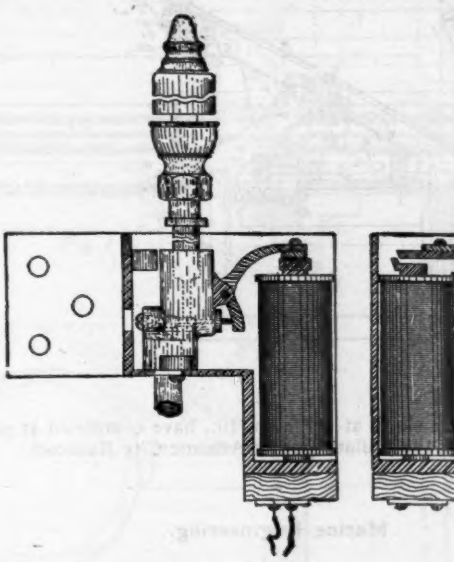


Fig. 1.

making and breaking contact. This is a necessary element, and this coupler, it is said, has shown itself capable of insuring good contact at all times. The interior pin has a tongue fastened to it, as shown, which joins the overlapping ears when the coupling is made and broken. This automatically makes contact when so doing, and blows the signal. This occurs either when the coupling is pulled apart violently by the breaking of the car-coupler, or, in making up a train, notifying the engineer to try his air.

The contact pull, fig. 3, is placed over the door, connected at one end by a cord which runs to the rear end of the coach and by a short end to the hood in front; pulling either end dips the plunger in against the contacts and closes the circuit across, making a multiple connection with the line underneath the coach with which it is connected. The connecting wires pass up through the water-closet. By reason of the metallic springs rubbing against the plunger, the ends of the same are kept constantly bright and in operative condition.

The battery is of the Gassner type of dry battery, which has been tried in this connection for four months, accurate meas-

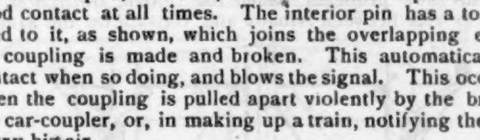


Fig. 2.

urements being taken at different intervals, and no deterioration in the output of the same being found in the trial. The eight cells are worked through a resistance of 27 Ohms, insuring a long life. The Company agrees to guarantee this battery for two years intact, and it can be recharged at the end of that period. It is placed in a tray-box under the running-board on the engineer's side, and spring contact with the line is made automatically in placing the tray in position. A dry battery is considered superior to a wet one, owing to the amount of oscillation and shake to which it is subjected in its position.

Facing the platform the connection of the wires is placed to the left of the drawhead, which position leads the couplings across the air-hose at right angles. The wiring runs from thence to the left cell for the entire length of the coach; it is covered and lagged and thoroughly protected from the weather and any ill usage to which it would necessarily be exposed by being hung in suspension or held by cleats to the car underneath.

Manufacturing Notes.

THE Bucyrus Foundry & Manufacturing Company has removed its Chicago office from its former location at 115 Dearborn Street to Room 656 in "The Rookery," corner La Salle and Adams streets. This office is under the management of Mr. E. W. Cramer, who represents both this Company and the Bucyrus Steam Shovel & Dredge Company, in Chicago and vicinity.

IN issuing a sketch showing the standard flange and tread, Messrs. Thomas Prosser & Son, representatives of the Krupp Works, say: "Unless otherwise requested, we will in future

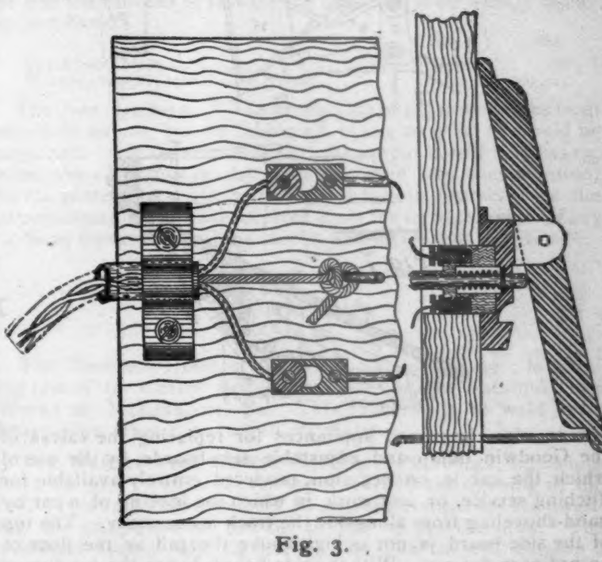


Fig. 3.

furnish all locomotive driving-wheel tires, leading locomotive truck wheels, tender wheels, and car-wheels, with the flange and tread shown on sketch enclosed, as it seems to be the general disposition of railroad officials to adopt this flange and tread as a standard, and most of the orders we have lately received specify same.

"A few months ago we had on file between 75 and 100 different styles of flanges and treads, and are pleased to report that hardly without an exception the parties using them have notified us that they have adopted as a standard the flange and tread adopted by the Master Mechanics' and Master Car-Builders' Associations, and it is hoped it will be made the 'Standard' in every sense of the word."

THE Acme Machinery Company, Cleveland, O., has recently added to its works an erecting shop 50 X 120 ft., and two stories high, and also a three-story building containing offices, drawing-room, and tool-room. In the erecting shop there is a five-ton traveling crane, built by the Brown Hoisting & Conveying Machine Company. The Company recently shipped five 5-in. bolt-cutters and one 6-in. bolt-cutter, one of the largest orders of the kind ever filled.

THE Baldwin Locomotive Works has just ended negotiations with the Roanoke Rolling Mill, of Roanoke, Va., for the purchase of 200 tons of bar iron. The price at which the sale was conducted is not given, but it is understood to be below the price ruling for Pennsylvania iron. This sale is said to be the first transaction in Southern manufactured iron consummated in this State.—*Philadelphia Inquirer.*

THE Westinghouse Machine Company, Pittsburgh, Pa., is fitting up a new machine shop for large work. A very large new planer, by William Sellers & Company, is already erected and in operation, and a large new cylinder boring-machine, of special design, by the Pond Machine Tool Company, is now in process of construction. Other large tools will be added. The new shop is rendered necessary by the Company's heavy run of orders for large compound engines. These include several of 200 and 250 H.P. from the Southern Cotton Oil Company, the

Baldwin Locomotive Works, and other parties. The Company has recently sold smaller engines for electric lighting plants in Havana, Cuba, and Madrid and Barcelona, Spain.

The Goodwin Dump-Car.

THE accompanying illustrations show an improved form of the Goodwin dump-car. The improvements are covered by Patent No. 403,584, dated May 21, 1889, and issued to John M. Goodwin, of Sharpsville, Pa. The improvements include a detent for the valves of dump-cars, designed particularly for use in the Goodwin car, but applicable to any car having swinging valves extending lengthwise of the cargo-box. The patent

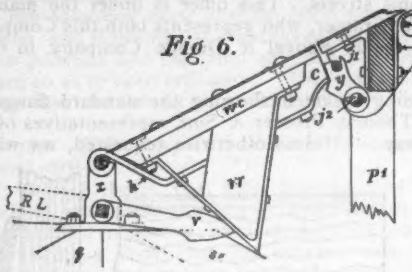


Fig. 6.

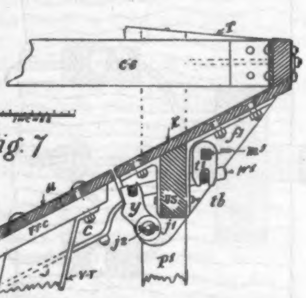


Fig. 7

covers, also, improved appliances for replacing the valves of the Goodwin dump and adjustable side-boards, by the use of which the car is, on occasion, rendered entirely available for ditching service, or any work in which the loading of a car by hand-shoveling from alongside the track is necessary. The top of the side-board is not as high above the rail as the floor of an ordinary flat car. With the side-boards in use the car dumps (all on one side or half on each side) in the same way as when loaded from chute or by steam-shovel.

In the illustrations, fig. 2 is a cross-section of the car (of four-wheeled form), showing the disposition of parts for dump-

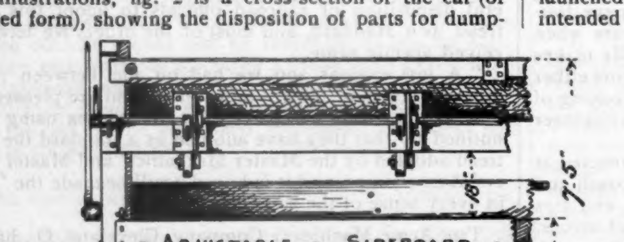


Fig. 8.

ing entire load on the side *D*. The adjustable side-board on side *U* is shown merely for the purpose of illustrating the mode of attaching such board, for use in case the loading of the car from the ditch, by hand-shoveling, is desired.

Fig. 6 shows the valve-replacing gear; the lever *R L* is operated by a man on the end platform of car. Fig. 7 shows the valve-detent arrangement; the detent withdrawing-rod, m^1, is operated by a lever at the end of the car. Fig. 8 is a side elevation of the half-length of the car, showing the adjustable side-board in place for ditching service, etc. Both valves of car are shown down. Fig. 9 is an end elevation of the car, with adjustable side-boards in place, the load to be dumped half on each side. In case dumping all on one side is desired, all that is needed is to raise one valve before loading.

The construction of the car in its improved form will readily be understood from the engravings.

Cars.

THE Indianapolis Car & Manufacturing Company recently delivered 100 fruit cars to the Louisville & Nashville Railroad.

THE Michigan Car Company, Detroit, Mich., is building 600 box cars for the Toledo, St. Louis & Kansas City Railroad.

THE Ohio Falls Car Company, Jeffersonville, Ind., has its passenger-car shop busy on orders. The freight shop is building 200 box cars for a Southern road.

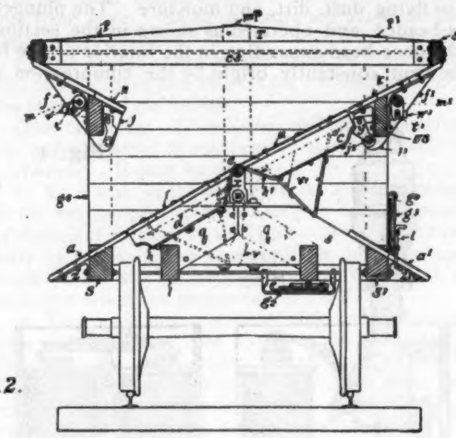


Fig. 2.

THE Pullman shops at Pullman, Ill., have completed 45 passenger cars for the Philadelphia & Atlantic City Railroad.

Marine Engineering.

THE Continental Iron Works, Brooklyn, N. Y., recently launched an iron propeller, called the *General Butterfield*, and intended to run between Albany and Catskill on the Hudson

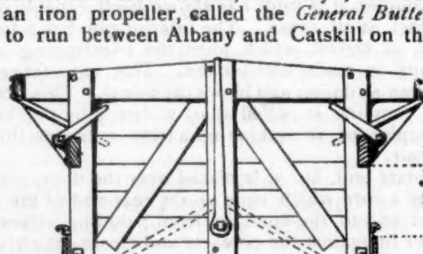


Fig. 9

River. The *Butterfield* is 130 ft. long on the water-line and 140 ft. over all; 28 ft. beam and 9 ft. 6 in. depth of hold. The motive power will consist of compound engines 17 in. high-pressure and 32 in. low-pressure cylinders and 24 in. stroke. The boilers will be of the ordinary horizontal tubular type. She will have three water-tight bulkheads and steam-steering apparatus.

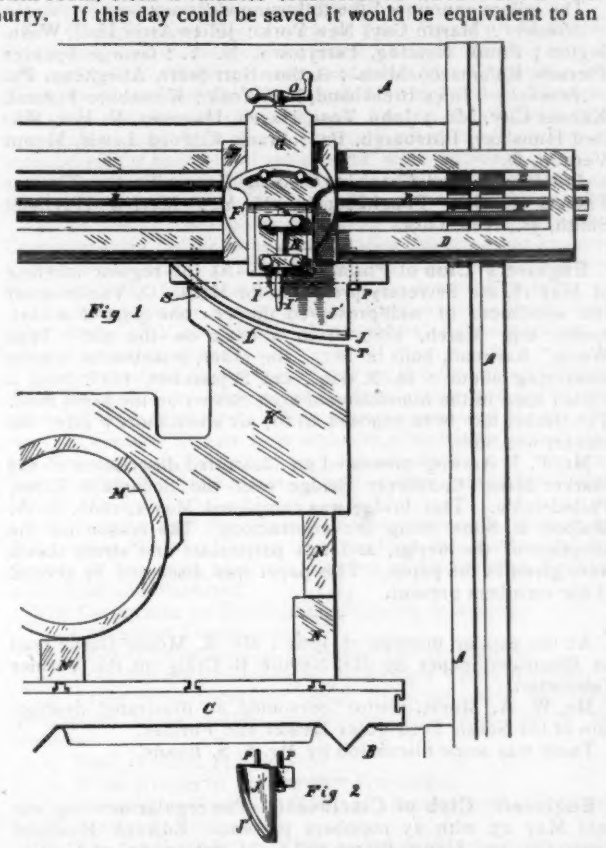
THE Risdon Iron Works, San Francisco, have recently fitted the steamer *Australia*, running between that port and Honolulu, with new boilers and triple-expansion engines. The boilers are of steel, and will carry 160 lbs. working pressure; they are two in number, 14 ft. 4 in. mean diameter, 16 ft. 4½ in. long; each boiler is fitted with 6 Fox corrugated furnaces, 3 ft. 4 in.

mean diameter, $\frac{11}{16}$ in. thick, having one fire-box common to each pair of through furnaces.

Planer Attachment for Curved Surfaces.

THE accompanying illustration shows an attachment for an ordinary planing machine, intended for use in planing curved surfaces, and especially the saddles of locomotive cylinders. This work, as is well known, is now done in a very crude way, by chipping the ribs, with which the saddle is made, by hand. The mechanic has to chip a large area of iron, just as it may happen to come from the sand, to fit the curvature of the boiler. In doing this it is necessary to lift the boiler into and out of the saddle until a trial fit is secured.

It may be mentioned that in one of the largest railroad shops in the country the price paid for chipping a saddle is $8.40, and the job usually takes four men a day. This means a day of track-room, often a valuable consideration when work is in a hurry. If this day could be saved it would be equivalent to an



addition of at least 10 per cent. to the capacity of the erecting shop.

This saving of time is not the only reason for doing this work by machinery. It is a common custom to use a sledge-hammer to pound the smoke-box so as to make a quick fit, and this is, of course, likely to strain the boiler in an undesirable way.

The attachment, which may be applied to an ordinary planer, is shown in the accompanying cut. Fig. 1 is a partial front view or elevation of a double-headed planing-machine, with the device attached thereto, only one head of the machine being shown; fig. 2, a small detached perspective view of the templet for the tool-holder.

The operation is as follows: The cut begins at the point *S*, and terminates at *T*. Thus, looking at the drawings, the traverse of the plate *F* on the screw-threaded rod *E'* is from left to right. The plate *G* is kept depressed by the operative, so as to hold the lower edge of the round-ended pin *I* down upon the templet *J*. After the carrying-plate *C* has carried the saddle under the tool *T* for the whole length of the saddle, the plate *C* is returned to the starting-point, and the tool is automatically shifted to the right for the next line of cut, in the usual way. This operation is repeated, the operative keeping the pin *I* down to its place on the templet *J*, until the whole width of the curved surface is planed. If it is found that one traverse of the whole curved surface is not sufficient, the operation can be repeated until sufficient metal has been removed to suit all requirements.

All boilers are accurate enough in diameter and general lines to conform with the surface of the saddle when planed.

This device is covered by patent No. 390,294, issued recently to G. M. Griffiths, of Philadelphia.

Blast Furnaces of the United States.

THE *Iron Age* gives the following statement of the blast furnaces on June 1, showing their condition and weekly capacity in tons:

	In Blast.		Out of Blast.	
Fuel.	No.	Weekly capacity.	No.	Weekly capacity.
Charcoal	60	10 962	96	8,754
Anthracite	91	34,386	82	24,728
Bituminous and coke	135	91,771	81	40,374
Total	286	137,119	259	73,856

The decrease in furnaces in blast during May was 10 in number, with a weekly capacity of 7,224 tons.

Comparing the statement with that for June 1 of last year, we find the number of furnaces in blast and their weekly capacity as follows:

	1889.	1888.
Furnaces in blast	286	298
Weekly capacity, tons	137,119	123,015

The *Iron Age* says: "The production of pig iron shrinks from month to month, but the falling off is not so great as would be supposed. Our reports show that the output is still very heavy, when the condition of the trade is taken into consideration. At the same time a distinctly hopeful feeling characterizes the communications we have received from the furnace men. Many of them report diminishing stocks and increasing inquiries."

Electric Notes.

THE Thomson-Houston Electric Company, Boston, is erecting one of its electric welding machines at the National Tube Works at McKeesport, Pa. This machine is to weld extra heavy pipe, from 1 in. to 3 in. diameter.

THE Westinghouse Electric Company, Pittsburgh, intends to have its new electric car on the market by the opening of the fall. It is said that a number of railroad companies are awaiting the completion of the car to test its practicability. The overhead system will be used. The new car will employ a Tesler motor, without any brushes or commutator, besides which no gearing will be employed. The alternating current will be used, which will reduce the size of the wire and largely augment the efficiency of the apparatus.

Locomotives.

AMONG other orders, the Baldwin Locomotive Works, Philadelphia, are filling one for 25 engines, with 19 × 24 in. cylinders, for the Texas & Pacific, and one for 15 freight engines for the Missouri, Kansas & Texas Railroad.

THE New York Locomotive Works, Rome, N. Y., are building four passenger engines for the Mobile & Ohio Railroad.

THE Cooke Locomotive Works, Paterson, N. J., recently delivered six passenger engines, with 19 × 24 in. cylinders, to the Newport News & Mississippi Valley Company.

THE Old Colony Railroad shops at South Boston have just completed four heavy passenger engines for the road.

Bridges.

THE Berlin Bridge Company, East Berlin, Conn., recently completed a bridge of 300 ft. span over the Connecticut River at Brattleboro, Vt.

THE Shiffler Bridge Works, Pittsburgh, Pa., have the contract for an iron bridge over the Kentucky River at Tate's Ferry, Ky. The channel span will be 300 ft. long.

THE King Iron Bridge & Manufacturing Company, Cleveland, O., is building 11 spans of iron bridge for the Richmond & Danville Railroad.

THE Variety Iron Company, Cleveland, O., is furnishing the iron work for a new bridge at Athol, Mass.

OBITUARY.

SILAS H. WITHERBEE, who died in New York, June 8, aged 74 years, was born in Bridport, Vt., and when but a boy entered a store in Port Henry, N. Y., as clerk. Subsequently he was connected with the Port Henry Furnace and later ran a transportation line on Lake Champlain. He went into the iron-mining business in 1852, and soon after formed the firm of Witherbees, Sherman & Company, which gradually became miners of iron ore on a very large scale, and owners of the Lake Champlain & Moriah Railroad, built to accommodate their business. He was also chief owner of the Port Henry and the Cedar Point furnaces, and held a very high position in the iron trade. Mr. Witherbee left a large fortune, chiefly invested in mining property and in real estate on Lake Champlain, in New York City, and in Newport.

PERSONALS.

PETER BRADY is Chief Engineer of the new Easton & Northern Railroad, and has his office at Easton, Pa.

MAJOR R. A. BACON has resigned his position as Superintendent and Chief Engineer of the Rome & Decatur Railroad.

S. D. BURTON has resigned his position as Superintendent of the Second Division of the Mexican Central Railroad, and has returned to the United States, where he will remain for the present.

WILLIAM HAINSWORTH, for a number of years Superintendent of the Pittsburgh Steel Castings Company, and more recently President of the Hainsworth Steel Company, has resigned both positions.

J. A. WISHART, late Master Mechanic of the New York & Canada Division of the Delaware & Hudson Canal Company's lines, has been appointed Master Mechanic of the Company's shops at Oneonta, N. Y.

CHARLES BLACKWELL, recently with the Central Railroad of Georgia, and formerly with the Union Pacific, has connected himself with the United States Metallic Company, of Philadelphia, and will have his headquarters in Chicago. Mr. Blackwell is a mechanical engineer of high reputation and extensive experience.

PROCEEDINGS OF SOCIETIES.

American Institute of Electrical Engineers.—The fifth annual meeting was held in New York, May 21. The following officers were elected, who, in addition to those holding over under the rules, will form the board of management until the completion of the fiscal year of 1890: President, Professor Elihu Thomson, Lynn, Mass. Vice-Presidents, Edward Weston, Newark, N. J.; Professor E. L. Nichols, Ithaca, N. Y.; Major O. E. Michaelis, Augusta, Me.; Dr. Louis Duncan, Baltimore. Managers, Dr. F. Benedict Herzog, H. C. Townsend, Henry Van Hoevenbergh, New York; Professor William E. Geyer, Hoboken. Secretary, Ralph W. Pope. Treasurer, George M. Phelps, New York.

The Council reported that there had been a net gain in membership of 60 during the past year.

The regular meeting for the presentation and discussion of professional papers was held on May 22.

The closing session of the general meeting took place at the College of the City of New York, in the evening of May 22, when Professor H. A. Rowland delivered a lecture on Modern Views in Respect to the Nature of Electric Currents. The lecture, which was illustrated by numerous experiments, was listened to with the greatest interest by over 300 persons, among whom were many of the representative electricians of the country.

Northwest Railroad Club.—At the regular meeting in St. Paul, Minn., June 8, there were discussions on Axle Dimensions and on the Rules of Interchange. Arrangements for attendance of members on the Master Mechanics' and the Master Car-Builders' conventions were also made.

New England Water-Works Association.—The eighth annual convention was held at Fall River, Mass., beginning June 12. Business sessions were held on that and the following day, at which a number of papers were read on Hydrants; Meter Rates; Records; Analysis of Water, and other subjects. There were also discussions on Sediment in Mains; Size of Pipes; Repairing Pipes; Lead Pipes; Lift for Pumps; Water Motors; Consumption and Waste; Driven Wells, etc.

June 14 was devoted to a programme of entertainment provided by the local committee.

American Society of Civil Engineers.—At the regular meeting, June 5, the death of General Adna Anderson was announced.

A paper on the Flood-heads of the Mississippi River, by William Starling, was announced, but its reading was postponed to the annual meeting at Seabright.

The most of the meeting was occupied by a discussion of the Johnstown disaster. Several members described the dam and the circumstances of its construction. By vote of the meeting Messrs. W. J. Becker, J. B. Francis, W. E. Worthen, and Alphonse Fteley were appointed a committee to visit the site of the South Fork Dam and report on its failure.

The tellers announced the following elections:

Members: Martin Gay, New York; Julien Astin Hall, Washington; Frank Nearing, Tarrytown, N. Y.; George Spencer Pierson, Kalamazoo, Mich.; Arthur Burr Starr, Allegheny, Pa.

Associates: Jules Breuchaud, New York; Kiosaburo Futami, Kansas City, Mo.; John Vose Hazen, Hanover, N. H.; Millard Hunsiker, Pittsburgh, Pa.; Frank Clifford Lewis, Mount Vernon, O.

Juniors: William Channing Cushing, Zanesville, O.; Thomas Francis Lawlor, Poughkeepsie, N. Y.; Merritt Haviland Smith, Jr., New York.

Engineers' Club of Philadelphia.—At the regular meeting of May 18, the Secretary presented for Mr. C. O. Vandeventer two specimens of well-preserved timber: one (part of a cart-spoke) dug March, 1889, from a bank on the old "Tape Worm" Railroad, built in 1837; the other, a section of timber measuring about 8 in. × 9 in., cut September, 1888, from a timber used in the foundation of arch culvert on the same road. The timber has been exposed to the air since shortly after the culvert was built.

Mr. F. J. Amweg presented an illustrated description of the Market Street Cantilever Bridge over the Schuylkill River, Philadelphia. This bridge was completed May 1, 1888, R. A. Malone & Sons being the contractors. The reason for the adoption of the design and full particulars and strain sheets were given in the paper. This paper was discussed by several of the members present.

AT the regular meeting of June 1 Mr. R. Meade Bache read an illustrated paper by Mr. Neville B. Craig on the Vernier Telemeter.

Mr. W. A. Morse, visitor, presented an illustrated description of the Smith Feed-water Heater and Purifier.

There was some discussion by Mr. S. S. Evans.

Engineers' Club of Cincinnati.—The regular meeting was held May 23, with 25 members present. Edward Mead, of Louisville, and Henry Pierce and C. H. Schumann, of Cincinnati, were admitted to membership.

Mr. R. L. Engle read an interesting paper on the construction of the Atchison, Topeka & Santa Fé Railroad from La Junta, Col., to Deming, N. M., in 1878-81. He described also the building of the Raton Tunnel, 2,011 ft. in length, and the temporary track on switch-back location over which to pass trains during the construction of the tunnel, which is remarkable for the short time occupied in its building, and the cheapness with which it was accomplished.

Engineers' Club of Kansas City.—At the adjourned meeting, May 20, a paper on the Inspection of Iron Bridges was read by Henry Goldmark. He referred to the action already taken on highway bridge reform, but considered the safety of railroad bridges to be of still more importance, and recommended a systematic inspection of such bridges.

The paper of the evening, Sewerage of the O. K. Creek District, was read by W. Kiersted, supplemented by remarks by A. J. Mason.

Engineers' Club of St. Louis.—At the regular meeting held May 29, the Secretary read a communication from the St. Louis Public Library on the subject of membership and permanent meeting places. The question was discussed by Messrs. Johnson, Holman, Seddon, Gale, Moore, Bryan and Bouton.

A paper on a new system of Fire-Proof Flooring was read by

Mr. P. M. Bruner, giving detailed particulars regarding the manufacture, erection, durability and cost.

The paper on Settling Water, by Mr. Seddon, was discussed by members present.

Engineers' Society of Western Pennsylvania.—The regular monthly meeting was held May 22, President Brashear in the chair. After the election of four members, Louis S. Clarke gave a very interesting account of the inception of the idea of fixing sound and the progressive steps to the present graphophone. His remarks were listened to with much interest.

Master Mechanics' Association.—The annual convention began at Niagara Falls, June 18, with a large attendance. After prayer and roll-call, President Setchel delivered the annual address, touching on the past development of the locomotive and the needs of the future. The reports of the Secretary and Treasurer were read and received, and the usual Committees on Nomination, Auditing, and Correspondence appointed. A number of new members signed the roll.

The Committee on Purification of Feed Water presented no report and was discharged, the subject being continued with a new committee. Reports were read from the Committee on Tires, the Committee on Form and Size of Exhaust Nozzles, and the Committee on Driving and Engine Truck Brass, the latter recommending as a new departure, the casting of boxes of solid bronze or brass. All the reports were discussed.

The volunteer discussions for the day were on the Bursting Steam Chests and on the Need of a Heavier Axle for Tenders.

On the second day reports were read and discussed from the Committees on Driver Brakes, on Boiler Covering, on Proportion of Grate Area and Flue Surface, on Form of Foundation Ring for Boiler Leg, and on Water Space around Fire-box.

The discussion on a new Tender Axle was continued, and joint action with the Master Car-Builders' Association on a heavier axle was advised.

The discussions of the second day on the reports on Driving Axle-boxes and on Driver-brakes were active, and called out many different opinions. The volunteer questions for the day were on Heavier Tender Axle and a new Standard Journal; on relative size of Cylinders and Smoke-stacks, and on Iron and Wooden Tender Frames. Time only permitted the discussion of the first.

On the third day the reports on Water Space in Boilers, on Foundation Ring for Boiler Legs, and on the Mechanical Influence of Iron and Steel on Watches of Locomotive-Runners were read and discussed.

The Committee on Subjects reported the following:

1. Compound Locomotives.
2. Testing Laboratories, Chemical and Mechanical.
3. Link Motion as Compared with Other Valve Motions.
4. Aside from Increased Grate Area, are there any other advantages to be gained by placing Fire-boxes above the Frames?
5. Steel *vs.* Iron Frames.
6. Brick Arches in Locomotive Fire-boxes.
7. Locomotive Tanks or Tenders; best method of preventing Corrosion in Coal-space.
8. The best proportion of Steam Passages in relation to size of Cylinders and Steam Pressure.

Upon motion these were also included:

9. Best Form and Size of Axles for Heavy Tenders.
10. What is the relative value of Small and Large Flues?

Resolutions were adopted for the appointment of a committee in relation to the standard coupler.

Chattanooga, Buffalo, and Montreal were designated as the places from which the Executive Board is to select the place for the next Convention. The usual resolutions of thanks, etc., were passed.

The following are the officers for the ensuing year:

President, R. H. Briggs, Memphis, Tenn.; First Vice-President, John Mackenzie, Cleveland, O.; Second Vice-President, Albert Griggs, Providence, R. I.; Secretary, Angus Sinclair, New York; Treasurer, O. Stewart, Charlestown, Mass.

The exhibition room provided this year was unusually large, and there were many exhibits of old and new devices, of which space will permit only a mention by name, as follows:

Car Heaters and Steam-pipe Couplings.—Erie Car Heating Company; Standard Car Heating Company, Pittsburgh; Williames Car Heating Company; Leland's Universal Coupling, New York; Northwestern Modern Car Heating & Lighting Company; J. M. Foster's Pressure Regulator; Mason Pressure Regulator; Gold Steam Trap; Ross Valve Company, Troy, N. Y., Reducing Valve.

Car Wheels.—New York Car Wheel Company, machined wheel; Boies Steel Wheel; Griffin Wheel & Foundry Company.

Couplers, Buffers and Drawbars.—Westinghouse Buffer; Butler Drawbar Attachment; Robinson Coupler Company, Springfield, O.; Tocin Automatic Car Coupler Company.

Snow-plows.—Jull Manufacturing Company, model of "Cyclone" plow; Rotary snow-plow, photographs.

Brakes.—Eames Vacuum Driver Brake; John Porter, Jackson, Mich., coupler for air-brakes.

Car Seats.—Scarritt Furniture Company, chairs and Forney car seat; Hale & Kilburn; Hartford Woven-Wire Mattress Company.

Car Springs.—A. French Spring Company, Pittsburgh.

Train Signals.—Griggs Automatic Air Signal Company.

Tools, etc.—Star Machine Company, Buffalo, Forge; Halsey Power Drill, J. J. McCabe, New York; C. F. Hall, Skaneateles, N. Y., Valve Refitting Machine; Belfield Injector, Philadelphia; Buffalo Steam Pump Company.

Boiler Covering.—Chalmers-Spence Company, Asbestos Felt; Shields & Brown, New York, Boiler Covering.

Jacks, etc.—D. E. McSherry & Company, Dayton, O., Maxon Jack; Chapman Jack Company, Cleveland, O.; B. E. Tilden & Company, Cleveland, O., Replacing Frogs.

Metals.—Anti-Friction Metal Company, North East, Pa., Tempered Copper; Damascus Bronze Company, Pittsburgh; Thomas Prosser & Son, New York, Krupp Steel; Fox Solid Pressed Steel Company, Chicago; Buffalo Steel Foundry; Schoen Manufacturing Company, Philadelphia, Pressed Steel; Thomson-Houston Electric Welding Company, Boston.

Valves.—Richardson Balanced Slide Valve, Troy, N. Y.; Woolf Valve Gear Company, Minneapolis, Minn.

Packing, etc.—United States Metallic Packing Company, Philadelphia; Otley's Eureka Steam Packing, Chicago; Fairbanks & Company, Asbestos Valve-disks; American Indurated Fiber Company, Mechanicville, N. Y., Fiber Pipe, etc.

Miscellaneous.—E. Smith & Company, New York, Paints and Varnishes; Detroit Lubricator Company, Sight-feed Lubricators; Kalamazoo Railroad Velocipede Company; Smith's Portable Rail-saw; Hartford Steel Railroad Tie; Robinson's Security Railroad Check, New York; Union Manufacturing Company, New Britain, Conn., Skinner Combination Chuck.

On the second day a number of belated exhibits arrived, including the following:

Beaudry Forging Press; McGuire Manufacturing Company, Chicago, Star Grain Door; Fish Car Truck, Detroit; Lake Shore Locomotive Condition Indicator; Ashcroft Manufacturing Company, Boston, Valves, Indicators, etc.; Consolidated Safety Valve Company, New York; Fennell Car Coupler, Skaneateles, N. Y.; Barnum Cylinder Relief Valve, Buffalo, N. Y.; Hoffman Machine Company, Detroit, Mich., Pendry Balanced Throttle Valve; Guarantee Tool Company, New York, Samson Wrench; Gould-Tisdale Revolving Semaphore, Boston; Shaffer's Oil Saver; Jerome Metallic Packing; Western Valve Company, Chicago; Knapp Steam Coupler; Susemihl's Car-door, Grain-door, Side-bearing for Car Trucks and Axle-box Cover; Metallic Grain-Door Company, Detroit.

NOTES AND NEWS.

The International Marine Conference.—The delegates from the United States to the coming International Marine Conference met in Washington, April 25, and organized. At various meetings since held they have completed a detailed programme of subjects to be considered which will be transmitted to the several powers who have agreed to take part in the Conference in October next. The general headings of this programme are as follows:

1. Marine signals or other means to plainly indicate the direction in which vessels are moving in fog, mist, thick weather or snow, and at night. Rules for the prevention of collisions. Rules of the road at sea.
2. Regulations to determine the seaworthiness of vessels.
3. Draft to which vessels should be restricted when loaded.
4. Uniform regulations regarding, designating and marking of vessels.
5. Saving life and property from shipwreck, including saving from shipwreck by operations from shore; official inquiries into shipwrecks.
6. Necessary qualifications for officers and seamen, including tests for sight and color blindness.
7. Lines for steamers on frequented routes.
8. Night signals for communicating information at sea.
9. Warnings of approaching storms, including transmission of warnings and uniformity of signals.
10. Reporting, marking, and removing dangerous wrecks and obstructions to navigation.
11. Notice of dangers to navigation. Notice of changes in lights, buoys, and other day and night marks.

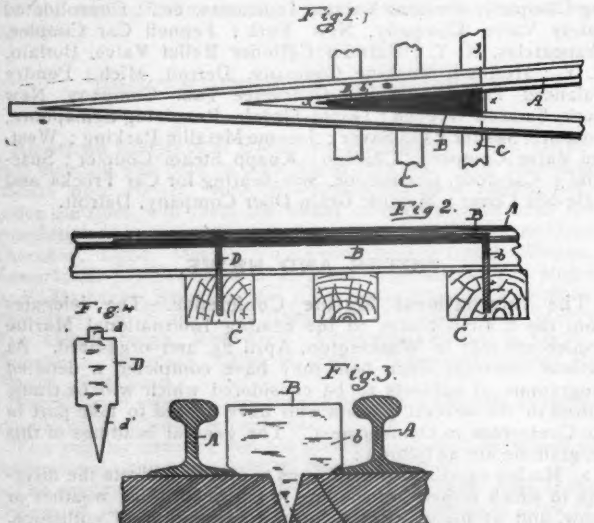
12. A uniform system of buoys and beacons.
13. Establishment of a permanent international maritime commission.

Foot-guard for Frogs and Switches.—The accompanying illustration shows a new pattern of foot-guard for frogs and switches. Fig. 1 is a plan view of the foot guard in place at a frog. Fig. 2 is an enlarged section through the line $x\ x$ of fig. 1; fig. 3 is an enlarged view on the line $y\ y$ of fig. 1; fig. 4 is a detail of spike.

A represents a frog of ordinary construction, but it is evident that the guard can be used in any tapering space between rails. *B* is the guard, which consists of a tapering piece of metal, preferably iron, the larger end, *b*, turned down at right angles, or nearly so, and pointed in such a manner as to be driven into the tie. A shoulder, b^2, is formed to limit the depth to which the end can be driven into the wood of the tie. A number of holes, b', are formed in the guard near the smaller end, this line of holes extending over a space greater than the distance between the ties, so that one of them will always come over a tie.

A spike, *D*, is provided for the purpose of supporting the smaller end of the guard. This spike has at its upper end a tongue *d*, adapted to fit the holes b' of the guard and to extend through the same sufficiently far to be riveted on the upper side. On the lower end of the spike a shoulder limits the extent to which it may enter the tie. The guard is placed in position by driving the large end into a tie at a suitable point, passing the head of the spike *D* through one of the holes b', which comes over a tie, driving the spike into the tie, and riveting the head of the spike in place. The length, width, and the taper of the guard are to be adapted to the position in which it is used, although it is not necessary to have each guard fit exactly, as one size will fit a variety of angles. It is only necessary that the guard shall fill the space so that no opening is left large enough to allow the foot to enter.

The height of the upper surface of the guard is governed by the position of the shoulder b^2 and the shoulder on the spike *D*. As here shown, the upper surface of the guard is approximately on a level with the top of the rail; but when placed where the flanges of the wheels pass over it it may be made lower, so that it just clears the edge of the flange, or it may be made level with the top of the rail, as shown, with a space between its edge and the edge of the rail for the flange of the car-wheel to pass through.



A guard so constructed has the advantage of cheapness and simplicity; it can be readily placed in position without special adjustment, and it will remain in place without liability of being displaced. A few different sizes of guards will fit the many places on a railroad where they are needed.

This foot-guard is the subject of Letters Patent No. 402,209, recently issued to Charles H. Wakefield, of Sherbrooke, Canada.

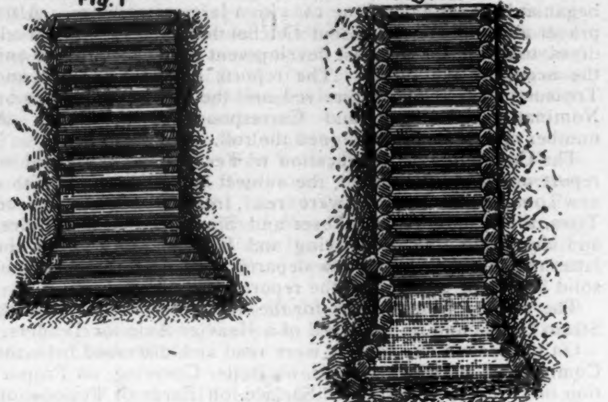
Russian Method of Timbering Wells.—A plan for timbering wells in order to protect the diggers from slides and falling of earth, which is shown in the accompanying illustration, is used extensively in Russia. Fig. 1 shows such an arrangement with squared timber, and fig. 2 with round timber or logs; the latter is more generally used.

The frames or shafts are generally square, from 56 in. to 84 in. on a side; they are made of logs from 6 in. to 10 in. in diameter. At the ends tenons are cut about as long as the diameter of the log and one-half its thickness. The logs, when laid together in order, thus engage at the ends and form a solid frame.

In practice the well-diggers generally excavate a hole from $4\frac{1}{2}$ ft. to 7 ft. deep, according to the greater or less looseness of the soil. The box or wall is then built up, starting from the bottom of the hole, and the diggers proceed with their work, adding more logs from below, so that the framework is continually growing downward, so to speak.

When the excavation reaches a point within about 7 ft. of the subterranean stream or spring, as ascertained by sounding or boring, the frame is no longer carried straight down, but is gradually spread by making each course of logs a little larger

Fig. 1 Fig. 2.



than the one above it; the base or bottom thus forms a square truncated pyramid, the faces being inclined about 40°. After striking water the lower part of the frame is carefully braced to keep it in place, and the well proper, or part which collects the water, and from which it is taken by the pump, is built below. The top of this is generally the same size as the lowest course of logs of the frame; its size and depth vary according to circumstances.

Arrangements for lining and curbing also vary, but the curb can readily be fastened to the top of the frame. It should be noted that the earth is carefully packed down around the frame when it is first put in place.

Scientific Judges.—Our readers may remember that, last autumn, *apropos* of a great patent case of colossal dimensions which was then before the Courts, we published an article urging that, in the interests of speedy justice, no less than for the dignity of science and its professors, it was most desirable that advantage should be taken of the provisions which already exist in our law, and especially in the Judicature Act of 1873 and its amending statutes, and in the rules of the Supreme Court framed under them, for the employment of scientific assessors or experts to aid the judge in strictly scientific cases. It may be remembered that, even in the very case on which we then commented, the tardy employment of Professor Stokes to aid Mr. Justice Kay was productive of most satisfactory results. We are glad, therefore, to notice that, in a case of some difficulty which came before Lord Coleridge last week, the same eminent man was again called in, and again with the result of relieving the Court from the task of hearing a mass of expert evidence with which no judge and jury are competent to deal satisfactorily. The whole question at issue was whether a certain anemometer, of which one of the parties was patentee and the other the purchaser, came up to the description of its qualities given by the vendor. A considerable array of counsel appeared on both sides, and it was arranged that the services of Professor Stokes should be called in to the aid of the Court. Seven of the anemometers were submitted to him, and, after an investigation by him, his report was read, and upon it judgment was given. The result is, that the report of the case occupies less than a third of a column of the *Times*. Without the services of Professor Stokes, or some similar sworn expert, we should have had half a dozen or more expert witnesses on one side contradicted by half-a-dozen expert witnesses on the other side; a case which would have lasted three or four days before a wearied judge, conscientiously striving to understand purely technical details, and a perplexed and confused jury; great loss to both parties; an unsatisfactory result; and, as we think, no little scandal to science and scientific men. All this has been prevented by the very simple expedient of calling in an eminent man of science to make a sworn report on the purely technical details, and leaving the rest to the ordinary administration of our Courts. Herein, we are persuaded, lie the proper functions of scientific men in the administration of public justice.—*Nature.*